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CONSERVATION OF MINERALS[1]

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As an abstraction the idea of conservation of natural resources is widely accepted by the public. In fact, active opposition to the idea is almost non-existent. It is a safe and attractive phrase for publicists, politicians and party platforms, as well as a plausible caption for many laws. Yet for most people conservation remains a vague profession of faith, not tied down to realities or practical programs. To specialists in forests, parks, game, recreation, soils, water resources and minerals, conservation means many different things. In a recent survey at the University of Wisconsin it was found that conservation was receiving attention in twenty-seven different courses, in nearly as many departments, and that in no two of them was the subject defined in the same terms. The many so-called conservation laws in our state and federal statutes reflect an equally chaotic condition. Text-book definitions of conservation, in the very nature of the case, must be so generalized that they fail to convey any clear notion of the practical problems involved. To illustrate the difficulty of simplifying the concept of conservation I quote to you an attempt made by the twenty-seven units of the University of Wisconsin to agree on a general platform:

> Conservation is the effort to insure to society the maximum present and future benefit from the use of natural resources. It involves the inventory and evaluation of natural resources; calls for the maintenance of the renewable resources at a level commensurate with the needs of

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society; and requires the substitution, where the conservation of human energy permits, of renewable or inexhaustible resources for those which are non-renewable, and of the more abundant non-renewable resources for the less abundant ones. It not only seeks to eliminate waste of resources if use is economically feasible, but also looks forward to improvements in techniques of production and use, and requires that there be prompt and proper adjustments to advances in technology. It thus appears that conservation involves the balancing of natural resources against human resources and the rights of the present generation against the rights of future generations. It necessitates, moreover, the harmonizing of the procedures and objectives of conservation with the conditions of the present or future economic order, and calls for a careful allocation of duties and powers among private and public agencies.

To students of conservation this definition is comprehensive and tangible, but to the public it can scarcely be other than an euphonious abstraction. It is almost inevitable that plans and legislation must be developed piecemeal from many standpoints, and that the synthesis of the parts into a consistent program for natural resources as a whole must be a slow and difficult task on which we have barely started. Even within the special fields there are still large gaps between general concepts and workable plans.

I propose to-day to review briefly the practical problems of conservation of one group of natural resources—our minerals—a field in which we start from a well-established body of facts, sufficiently limited and defined to be studied with some degree of objectivity. Some of the ideas developed from the study of minerals may be found useful in approaching the problems of conservation of other natural resources.

I shall draw freely, but not solely, from the preliminary report recently issued by the Planning Committee for Mineral Policy, which was appointed by the President to formulate a national mineral policy. The Planning Committee is also acting as the Mineral Section of the National Resources Board. Its report was a part of a more general statement by the National Resources Board which was submitted to the President early in the year and by him transmitted to Congress with the statement that it constitutes "a remarkable foundation for what we hope will be a permanent policy of orderly development in every part of the United States."

Factual Statement of the Mineral Situation

First, a few salient facts of the mineral situation bearing on the problem of conservation. Ours is the age of the power machine, and minerals furnish both the power and machine. Minerals are a non-reproducible and exhaustible resource—a one-crop resource; they are limited in quantity; they are fixed geographically for all time; they are not distributed equally among the countries of the world. The United States stands far in front in the amount and variety of its resources, but still depends on foreign sources for part or all of its supplies of about 20 industrial minerals. The flush of discovery in the United States is passed, and the main geographic outlines of the ultimate mineral picture are now pretty well established. Reserves can be approximately measured. Discovery has not stopped, but the rate has been slowing down for a considerable time. Of 33 metal-mining districts that have yielded the greatest wealth to date only five have been discovered since 1900 and none at all since 1907. The coal and iron fields are pretty thoroughly mapped. The chance of finding another Mesabi Range or another Pittsburgh coal field is small indeed. The rate of discovery of oil and gas still continues high, but the geological limitations are pretty well understood, and the chances of finding another East Texas or Kettleman Hills are not promising.

Finally, the United States leads the world in the speed with which it is exploiting and exhausting its resources. For the metals and fuels, despite a magnificent endowment, depletion is further advanced than even mining men generally realize. In gold the peak of American production was passed in 1915, and despite the enormous stimulus of falling commodity prices and devaluation of the dollar, production to-day is still far below the pre-war level. In silver, also, we seem to have passed the peak. The copper mines of Michigan have gone a mile below the surface, by far the deepest copper mines in all the world, and at those depths, despite the ablest of engineering, they are quite unable to compete with many low-cost districts here and abroad. Mining at Butte has reached deep levels and has long since passed its peak. The great tri-state zinc district of Missouri, Oklahoma and Kansas is no longer expanding, and no notable geographic extensions are in sight. In the oil industry the glut produced by east Texas makes us forget the hundreds of dead or dying pools in other areas. The Southwest gas production hides the decline of many eastern districts and the death of the Indiana gas belt. Even in coal, one of the most abundant of our resources, it is estimated that the anthracite fields of Pennsylvania are 29 per cent. exhausted. While the total supply of bituminous coal is huge, the exhaustion of the best of the bituminous beds, such as the Moshannon, the Big Vein, Pocahontas, New River and Pittsburgh, is well advanced. About half of the known high-grade iron ore of the Lake Superior region has already been produced.

The speed of our attack on mineral resources is indicated generally by the fact that the amount produced

since the opening of the century far surpasses the total of all preceding history of the United States. In this respect we are literally digging ourselves in to our natural environment on a scale which has no precedent in history.

In terms of years of measured reserves of present commercial grades the United States has supplies of oil, zinc and lead for from 15 to 20 years. Its copper supply is good for about 40 years. The total for iron ore, including its lower grades, such as Alabama, is good for hundreds of years, but the known reserves of high-grade Mesabi ores now supplying about half of our requirements will last about 40 years, and for the rest of the Lake Superior region, supplying about 30 per cent. of our requirements, the figure is less than 20 years. Coal reserves of all kinds, high and low grade, favorably and unfavorably located, will last 4,000 years, but the kinds we are now using in favorable location are measured in a century or two.

Minerals in which the United States is wholly or partly deficient include antimony, asbestos, chromite, manganese, mercury, nickel, tin, tungsten and ten or twelve others.

Further discovery and the use of lower grade resources will extend the life of most of these resources, but the range of possibilities is now pretty well understood, and with maximum allowance for such extensions, the figures are sufficiently small, when compared with what we hope to be the life of the nation, as to be matters of public concern.

The depletion of mineral reserves here sketched has been accompanied by huge losses, some avoidable and some unavoidable. It is estimated that not more than 50 per cent. of oil is recovered from a pool, even under efficient recovery practices; where extraction methods are wasteful of gas and reservoir energy, a commonly accepted average is 10 to 20 per cent. In one field a billion feet of gas are being blown into the air daily —enough to supply the United Kingdom twice over and forty times as much as all the Scandinavian countries use together. In twelve years in California the quantity of gas known to be lost was about one third of that produced for commercial use. The average loss in the recovery of coal is 35 per cent., as estimated by the Bureau of Mines. The mining of iron, copper, lead and zinc—in fact, of most minerals—shows waste, due to the necessity for selective mining to meet competitive price conditions or the burden of excessive taxation. In the Lake Superior region large tonnages of low-grade iron ores have been left behind in the progress of mining, many of which will never be recovered after the operations close down. The list of specific losses could be extended indefinitely. Loss of resource is not a theory or an insignificant incident; it is a demonstrable fact, which can be documented in detail and which runs into large figures.

Mineral Conservation Defined

I have briefly summarized these few salient facts as a basis for defining the problem of conservation of mineral resources. When the nation became conscious, about the turn of the century, that its mineral reserves were not inexhaustible, men pictured a day of wrath when all the coal and oil and iron would be consumed. Then, when the looked-for shortage did not occur, a feeling rose that conservation was a cry of "Wolf!" and a reaction set in. The popular concept of conservation had been over-simplified, and it still is. As we see it now, conservation means not hoarding, but orderly and efficient use in the interest of national welfare, both in war and peace, without unnecessary waste either of the physical resources themselves or of the human elements involved in their extraction. The central idea of mineral conservation is that the impetuous expansion of the pioneer days should, in the public interest, give way to more orderly and less wasteful development. The danger is not absolute exhaustion in some indefinite future, but rather an early increase in cost through unnecessarily early depletion of the rich and accessible deposits. Already signs begin to appear that domestic industries are feeling the pinch of competition and finding it difficult to meet the pressure emanating from younger countries, which are still discovering new resources.

Large losses of raw materials are accelerating this trend. The conditions that are causing the physical losses are also causing human losses—irregularity of employment and low standards of living. Likewise these conditions are causing capital loss. The physical, human and financial losses are closely interrelated, and no one of them can be effectively treated without consideration of the others.

It does not follow that all the known losses are avoidable wastes; that they are principally due to incompetent, careless or selfish exploitation. Examples of such exploitation of course are known, but they are not typical of mineral development as a whole. With few exceptions, the record is one of honest effort to do the job as efficiently as circumstances have permitted. The conservation problem is not principally one of punishing scapegoats, though this very human tendency to personalize and dramatize pervades much of the popular discussion of the subject. It is too bad for the cause of conservation that the scientist has to deal with the subject in unemotional terms.

In the early stages of the development of a mineral deposit, before all the conditions are known, losses are inevitable, and even when the conditions are

known, financial pressure may limit the application of known processes for better recovery. In some cases it may be good conservation to save two dollars' worth of human energy at the expense of wasting a dollar's worth of raw materials. Man's interests are, after all, paramount in his adaptation to his physical environment. However, the first crude adjustments to environment inevitably point the way to more skilful adjustments, in which the physical losses may be lessened without excessive cost to the human elements involved.

It is only since the war that the conservational problem as we now know it has really emerged in definite form. Up to the war, expansion of capacity for mineral production was more or less proportional to consumptive demand. Since then, capacity has outstripped consumption for several minerals, intensifying competition for markets, with consequent reaction on conservational standards. The principal problems of conservation are now centered in this group of minerals.

Practicable Steps in Conservation

What, specifically, can be done to advance mineral conservation as thus defined? To state our general conclusion first, the principal wastes are not due to lack of advancement in technological and scientific methods but to maladjustments in the economic and political conditions under which the industries are operating. The great opportunities for advances in conservation therefore lie in the economic and political fields. After brief mention of the technological and scientific gains, I shall call your attention particularly to the necessity of control of production, to the effect of taxation, to the desirability of extending the Leasing Act to all public lands and to international considerations affecting the problem.

(1) *Technologic and Scientific Attack:* Splendid conservational advances have been made by engineers and scientists in their attack on the physical problems of conservation. Recovery and efficiency in mining, concentrating and smelting have been greatly improved. The process of flotation has recovered large quantities of metal formerly wasted. Oil technology has greatly lessened the wastes in extraction from the ground and has doubled and trebled the amount of gasoline obtained from the crude. New methods and machinery have reduced costs of mining and concentration in nearly all fields. The record is a long and impressive one. The American mining industry has led the world in technological advances, which have furnished the American consumer his raw materials at the lowest unit prices available anywhere in the world. Physical conservation has pressed forward about as fast as economic conditions have allowed.

The driving power for this impressive advance has for the most part not been any social concept of conservation but the practical urge toward efficiency, lower costs and higher profits. The financial rewards to such efforts have been great and will doubtless continue to be so if given a chance to function by the conditions of the industries. Public encouragement of these efforts through scientific and technical bureaus has been an important contributing factor, and continuance of these efforts is, of course, a necessary element in any positive program of conservation.

(2) *Control of Production:* However, the great hurdles in the way of conservational advance are now the economic and political conditions under which the industry operates, which are damming up the effective application of technologic and scientific processes and which must be removed if we are to realize the results known to be possible. The practical problem of conservation is now one of finding new methods of stabilizing the conditions of the mining industry in a way which will allow of the effective application of these methods.

A review of the economic and social conditions affecting the mining industry reveals one dominating factor which is the cause of much the largest part of the wastes now going on. I refer to unrestricted competition, made compulsory by our anti-trust laws, which has led to overdevelopment, irregularity of production, prices and employment, and which has forced from time to time robbing of the best of mineral reserves to meet competitive conditions, and has thereby prevented the orderly development, with the use of all known technical knowledge, necessary to prevent huge wastes. Just a few cases to illustrate what I mean. Competition in the coal industry has always been intense because of the widely scattered reserves and the thousands of producing units. For years the industry has worked in surroundings of poverty. Testifying in the Appalachian Coals case in 1932, Howard N. Eavenson, who has recently been president of the American Institute of Mining and Metallurgical Engineers, stated:

> I think I could make the broad assertion that there is not a single bituminous mine in the country to-day that is not mining the very best coal that it has, and the cheapest, and is allowing portions of the mine to get into shape where a lot of the coal will never be recovered, because they can not afford, at present prices, to mine it.

The Bureau of Mines has estimated that failure to use the standards of engineering already shown to be feasible by the better companies accounts for a loss in recovery of 20 per cent., which means an avoidable loss of 150,000,000 tons per year, or enough to supply the entire requirements of Germany.

The headlong exploitation of oil under unrestrained competition has caused large overproduction, collapse of prices and the elimination of even elementary conservational practices of recovery. Some of the results are: (1) Operation of oil wells with improper gas-oil ratios; (2) actual physical wastage at the surface of prodigious quantities of vitally important gas, resulting in lower ultimate recovery of oil from the reservoir; (3) underground losses, resulting from migration of oil and gas through defective wells, from productive strata to beds from which the fluids can not be reclaimed, and also from invasion of water into the oil sand; (4) erection of excessive storage facilities above ground, resulting in needless expense and actual physical losses due to leakage, evaporation and fire; (5) use of inefficient equipment, resulting in losses of oil, gas, reservoir energy and, at times, loss of life; (6) consumption of distress oil, forced on the market by over-rapid development, for purposes in which other fuels should be used; and (7) premature abandonment, as a result of demoralization of crude-oil prices, of thousands of small pumping wells; these, if allowed to continue to produce, would still yield a large aggregate of oil.

A large contributing factor to overdevelopment of oil is the so-called "law of capture," which makes it possible for any operator to extract all the oil he can drain from a pool, regardless of property lines. When a pool is opened competing operators are forced into a wild scramble to see who can draw the most from the common pool. Gas is wasted in huge quantities, and gas pressures, so necessary for the effective recovery of the oil, are destroyed. The possibility and desirability of changing this law are being vigorously discussed.

To offset the effects of the law of capture, unit operation of pools by cooperative agreement has long been recognized as a desirable procedure. This method has been applied in a few cases on the public lands, with notably successful results. However, voluntary cooperation to this end has usually failed, and the authority has not existed for legal coercion.

Copper mines are laid out with a certain price level in mind and with a certain anticipated life. When prices collapse, due to unrestricted production, the initial plan of operation must all too often be discarded. Operators are driven to neglect the most elementary work of maintenance and are driven to "selective mining," thereby reducing the average value of the ore left behind and at the same time increasing future cost of recovering it. When pillars previously left for support contain bodies of high-grade ore, operators are forced to take them out, thereby allowing old levels and stopes to cave. As the shut-down continues, the damage grows progressively worse. Shafts and main haulage-ways collapse. Barren rock and ore are crushed and mixed together, making future separation difficult or impracticable. In Michigan and elsewhere mines are filling with water. If the present shut-down of our copper mines continues for many years more, there will be huge tonnages of ore hitherto counted as 10-cent or 12-cent copper that will actually cost 15 cents or 17 cents. Since the upset in copper-mining conditions, the actual grade of copper-bearing ore which it has been necessary to mine to meet the market has been over twice as rich as that recovered under normal conditions.

Similar conditions may be cited for the iron, lead and zinc industries, but the illustrations cited will serve to indicate the nature of the problem. It is to the possible remedies to which I want more particularly to direct your attention.

To make a long story short, the situation requires a more stable adjustment of production to demand and more uniformity of price and production conditions to make possible the planning and application of conservational practices. The industries concerned have long desired this, but have been handicapped in cooperative effort to this end by the anti-trust laws. Ineffective steps were taken under the Appalachian coal decision and under an agreement of oil-producing states, but the effect in both cases was slight. Sporadic collective efforts, skirting the edge of the anti-trust law, have temporarily improved conditions. With the enactment of the NIRA, production, capacity and price control became openly possible. The coal code effected a certain measure of production control through control of prices. Under the oil code production was controlled by the states under allocation of quotas from the central administration in Washington, later supplemented by special control of interstate commerce in oil shipped in excess of state allotments. The copper code contained provisions for reduction of stocks which in effect was a measure of production control. The lead and zinc codes contained provisions for production control which were not utilized. There is no question that the efforts to control production and prices aided greatly in the stabilization and improvement of conditions in the coal, oil and copper industries. Whatever the merits or demerits of the NIRA as a whole, the opportunity for cooperation which it offered to the natural resource industries was a definite gain for conservation.

With the destruction of the NIRA by the Supreme Court decision, production, price or capacity control becomes illegal, and the mineral industries most concerned are casting about for legislation which will permit their efforts toward cooperation for production control. While all the mineral industries most concerned have objected to some phases of the NRA

control, it is an interesting fact that without exception they are now asking for legislation which will reinstate production control, either by the Federal Government or, as in the case of oil, by the legalization of interstate compacts. Bills are now before Congress for accomplishing this result for coal and oil, and one is proposed for copper. Agriculture has long enjoyed the certain privileges of cooperation, such as those allowing cooperative marketing in the McNary-Haugen bill of 1926.

The Planning Committee for Mineral Policy, in its report to the President of December 1, 1934, in view of the emergency nature of the NRA, had recommended consideration of permanent legislation which would make possible the balancing of supply and demand in mineral resources in the interest of conservation. This is the problem that is now squarely before us. Its solution is now called for both in the interests of national welfare and for the preservation of the mineral industries. In essence the question is one of creating exceptions to the anti-trust laws for certain specified reasons and with specified controls.

What we have in mind is briefly, first, a statement of need and purpose of conservation of certain natural resources, calling attention also to the fact that the mineral industries, by their very nature, are partly interstate, because they are so largely consumed in states where they are not produced, and that conservation is clearly a matter of federal interest. It is proposed that the President should be given the right to allow voluntary cooperation to industries engaged in extraction of limited natural resources where the President finds (1) that unregulated competition has caused and will cause serious waste of an irreplaceable resource; (2) that stabilization of supply and demand by control of production, price and capacity will aid in reducing waste; (3) that the proposed code contains such additional provisions for the improvement of technical standards and the elimination of wasteful practices as seem to him reasonably attainable; and (4) that the proposed code contains provisions for the fixing of maximum prices, if necessary, by a public authority sufficient to protect consumers against unreasonable advance in price.

In other words, if an industry can make an affirmative case that its wastes are large enough to be a matter of public concern; that they are due to a lack of cooperation; that they can and will be remedied by cooperation, and if the industry will accept sufficient public supervision to insure that cooperation will be used for this purpose and not misused to collect excessive profits, the President may authorize these specific exemptions from the anti-trust laws. If the conditions for exemptions are not carefully specified, there is likely to be a rush for exemption on the basis of generalizations and promises. It would be easy to use the word conservation as a mere expression of good intentions. So far as we can now see, the only mineral commodities likely to qualify for exemptions as thus defined are coal and oil, and less certainly iron, lead, zinc and copper.

I do not go into the question of the relative merits of the various devices for cooperative control of production which are now being vigorously discussed. These vary for different industries, and it is altogether likely that false starts will be made before an effective procedure is found.

We further believe that we should look for the real driving power to enforce cooperation in the self-interests of the industries rather than in compulsion from the government. The natural urge toward efficiency and self-preservation, so clearly manifest in the mineral industries, coincides to a marked degree with the requirements of conservation. Also so much of the power for public compulsion now resides in the scattered police powers of the states rather than in the Federal Government that it is difficult to see how it can be effectively utilized in any uniform plan of compulsion. Under these circumstances voluntary cooperation seems to promise much the best chance of early and successful conservational results.

Of course such a program as here recommended would involve the establishment of some sort of a federal conservation board, with flexible power within the limits imposed by the general enabling act.

Whether legislation will take the form of a general enabling act for all minerals or special acts for different minerals remains to be seen. At present the trend in Congress is toward separate enactments.

May I remark parenthetically that a considerable part of this program, at least, seems to be possible without amendment of the Constitution, because it hinges essentially on exemptions from the anti-trust laws. Congress has already provided several exemptions from the anti-trust laws. Farmers and laborers were exempted by the Clayton Act, approved shipping agreements by the Shipping Act, agricultural associations by the Capper-Volstead Act, cooperative marketing agencies by the Cooperative Marketing Act, export associations by the Webb-Pomerene Act, railroad consolidations by the Transportation Act and AAA marketing agreements by the Agricultural Adjustment Act.

The plan of production control by voluntary cooperation under government supervision, which I have briefly sketched, is one generally favored by the Planning Committee for Mineral Policy, but there are other plans. A considerable part of the oil industry is now turning toward a wider use of the police powers of the states to restrict production, and is

asking Congress to legalize interstate compacts and to supplement them by control of interstate commerce in oil produced in excess of state allowances. The difficulty is that only five of the states have oil conservation laws—Texas, Oklahoma, Kansas, New Mexico and Louisiana. California and Michigan and other oil-producing states have none. Furthermore, the states have no control, of the kind exercised by the NRA, over refineries, where much of the trouble is focused. Generally speaking, this looks like a stopgap procedure based more largely on compulsory state powers than on voluntary cooperation, and the view of the federal oil administration is that sooner or later the industry may find it necessary to turn to the Federal Government for aid in stabilizing the industry by voluntary cooperation under government supervision. An administration bill of this kind is now before Congress.

Finally, there is the drastic alternative of outright nationalization of mineral resources to accomplish the desired results. Since the war there has been a rapid spread of nationalization in other countries, and it requires no gift of prophecy to predict that there will be increasing discussion of the possibilities of nationalization in this country. Certainly it will gain impetus if less drastic methods fail. In the space of this address I can merely mention this alternative as one which the Planning Committee for Mineral Policy regards as unnecessary and undesirable. It seems possible to accomplish the desired results by a method which will preserve a very large measure of private initiative which has so successfully developed the mineral industry.

(3) *Taxation:* Another important political factor in conservation is taxation. It is coming to be realized the world over that mineral resources are precious national assets, and the concept that they are a special heritage of the people is being reflected in rapidly multiplying special taxes applied to natural resources. In addition to the usual ad valorem and income taxes, there are royalty taxes, severance taxes, occupation taxes and tonnage or production taxes. In the state of Minnesota the heritage principle is frankly recognized not only in the multiplicity of taxes on iron ores but in the ad valorem taxation of iron ores at 50 per cent. of their value as against 40 per cent. for the next highest class of property. I state these facts not in the spirit of complaint against high taxes *per se*—all industries have this complaint—but to indicate its bearing on the problem of conservation. Whatever its purpose, special taxation of natural resources, without corresponding reduction of ad valorem taxes, is resulting in mounting costs, which for some minerals and some districts constitute a direct barrier to the best conservational practice. To get by, under the existing price conditions, it is necessary to mine only the best and cheapest ores. To-day on the Mesabi Range taxation is a large factor in forcing the concentration of mining on the cheapest open pit ores and holding back production from underground mines and from the class of low-grade ores that need beneficiation, which ought to be proceeding simultaneously if the Mesabi Range ores are to be fully recovered at reasonable costs.

The taxation problem is a complex one, with no easy solution in sight. It may well be that the needs of uniform revenue should to some extent override conservational considerations, but I think there are few students of the problem who do not feel that corrections and adjustments are possible in the interest of conservation. The most promising line of attack, as suggested by the report of our Planning Committee for Mineral Policy, would seem to be the possible abolition of ad valorem taxes on natural resources or more flexibility to adjust them to capacity to pay, and the substitution of production taxes of one kind or another, to be paid on the ores as they come out of the ground. The deadly repetition of ad valorem taxes on unused ore in the ground through a long series of years is piling up charges against reserves which are not likely to be compensated for by increasing prices in the future, and which will have to be absorbed to whatever extent is possible in cheap and wasteful methods of recovery, which will hasten extraction of high-grade ores.

(4) *Extension of Leasing Act to All Public Lands:* The slowing down of mineral development on the public lands, which started with the passage of the Leasing Act in 1920, has been a salutary step in the direction of curtailment of production to balance consumption. For instance, 15 per cent. of our measured oil reserves are to-day covered by the Leasing Act on the public lands, but only 3 per cent. of the production comes from this source. Our committee believes that the extension of the Leasing Act over all minerals in the public lands, except possibly for Alaska, would be a step in the direction of conservation and a necessary corollary of any general plan of production control.

(5) *International Considerations:* I have indicated some of the political elements of the conservation problem in our domestic field, but these alone will not solve the problem. The United States does not exist in a vacuum. Our minerals are involved in international trade and are influenced by tariffs, international trade agreements and cartels, and the so-called "open door" or "closed door" policies for mineral development.

The world-wide flare of economic nationalism has resulted in the overdevelopment of the world's min-

erals in the attempt to make each country as nearly as possible self-supporting, both in war and peace. This has lessened international trade in minerals and the products into which they are made. The pressure of surplus production and capacity has tended to lower world prices. At the same time, the domestic consumer of some minerals in some countries is paying excessive prices for the development of low-grade and marginal supplies under the protection of tariff walls. From a world standpoint there is the same need, in the interest of conservation, for balancing supply and demand as in the domestic field. Various international trade agreements and cartels are to be regarded as the first step in this direction, and on the whole as conservational in their effect.

In analyzing the practical effect of the world situation on our domestic problem of conservation it should be remembered that our principal wastes are confined to a small group of minerals which are developed in surplus—oil, coal, copper, lead, zinc and iron. The stabilization of these industries at a high enough price level to permit proper conservational practice will undoubtedly limit our export trade in competition with the rest of the world. This trade, however, is already being rapidly lost through the growth of competitive centers elsewhere, and could be recovered, if at all, only by cheapening our products so greatly as to intensify the already great wastes inherent in unregulated competition. Our export of coal has always been a negligible part of our production. Export of oil has been large, but is rapidly disappearing under foreign competition, and probably should disappear because our known reserves are already small for our own future use. Our former large copper exports have dwindled almost to the disappearing point, except for a recent flurry which can be traced to war preparations abroad, and it seems likely that most of this market is permanently lost because of competition of new great sources abroad in Chile and central Africa. Export of lead and zinc has been negligible. Export of iron ore has been limited to very small amounts to Canada, though our manufactured iron and steel products have enjoyed a considerable foreign market. This market also is diminishing because of intensified competition abroad.

In short, the export trade in minerals is disappearing anyway, and the further loss which might result from stabilization of domestic industries on a plane which would permit of conservation would seem to be a relatively small sacrifice to offset the gains in conservation which are possible in adjusting the industries to our own markets at reasonable and steady price levels and the lengthening of the life of our own limited supplies. However, we must face the fact that it is a sacrifice, and the gains and losses must be carefully weighed.

Such a program involves the maintenance of tariffs for the surplus minerals and their adjustment to protect whatever standard of domestic economy we may set as our goal. Tariffs should be regarded as supplementary measures to protect situations built up in this country, and not as the principal instrument for such building. History has shown that some of our mineral tariffs designed to raise domestic standards, as in oil and coal and copper, have not in themselves brought about the desired result. By deciding first on our domestic program of conservation, we can then better judge the size of tariffs necessary to protect the situation.

There remains to mention another group of about 20 industrial minerals for which this country has always been dependent, wholly or in part, on foreign sources, and is likely to remain so. Much can and should be done in the way of development of some of the low-grade and marginal supplies of these minerals which we possess, but again history has shown that tariffs have been an ineffective method of bringing about this result and have merely expedited our raid on the few high-grade deposits available. Some of these minerals, like mercury and manganese, are very essential for war purposes, and the early exhaustion of very limited high-grade deposits existing in this country would be disastrous to future preparedness. If further discoveries of raw materials and development of technological processes to make them available should largely increase our supplies, then tariffs might be necessary to protect the industries, but only then. As a substitute for tariff our committee has recommended direct expenditures or subsidies by our government and states as likely to bring better results, as illustrated by the successful development of potash and helium by this method.

Conclusion

In briefest summary, then, the mineral conservation problem of the United States comes down to the following elements:

(1) Continuance of technological and scientific improvements already under way.

(2) The balancing of supply and demand in our so-called surplus industries at a price level which will permit of proper conservational practice; this to be accomplished by voluntary cooperative efforts of the industry under government supervision, through legislation which will exempt them from the anti-trust law; the exemptions from the anti-trust law in the interest of conservation to be specifically defined and public supervision to be provided to make sure that the wastes on the basis of which exemption is claimed can and will be eliminated.

(3) The legalization of some method of coordinating

the highly chaotic efforts of the individual states under their police powers, and support any collective efforts the states may attempt. Much of the authority necessary for production control now exists only in the police powers of the states. Since the Supreme Court decision, Washington is now struggling with the problem of finding authority for any national control. On the outcome of this major issue of federal versus state rights will depend largely the success of any effective program of conservation.

(4) Federal control of interstate shipments of minerals shipped in excess of quotas set by the state police powers.

(5) Possible abolition of ad valorem taxes in favor of taxes of one kind or another on current production.

(6) The use of tariffs for the surplus group which will protect any domestic economy built up in the interest of conservation, which may result in some further sacrifice of our already dwindling export trade because of the necessary maintenance of domestic prices above the world level.

(7) For the deficient group of minerals derived in part or in whole from foreign sources, to desist from a tariff program which merely hastens the exhaustion of our limited high-grade supplies and to substitute direct expenditure by the government on the problem of finding additional supplies.

In the last analysis, the practical basis for mineral conservation is voluntary cooperative effort under permissive legislation, which will carry safeguards against its misuse. The natural evolution of the industry, under the driving power of self-interest, has been in the direction of larger commercial units and cooperation. The relatively few large sources of mineral supply create a situation which lends itself to concentration of commercial control and even monopolies for some of our minerals. As the units of the industry, commercial or cooperative, grow in size and power, there is an inevitable growth of public interest and concern. Cooperation and public supervision are complementary and parallel developments which are not in conflict unless one or the other proceeds too fast. It is the hope and belief of our Planning Committee, based on the history of the few cooperative efforts thus far tried, that in the long run enlightened self-interest of the industries and the public interest may be made to coincide in a common program, which will avoid, on the one hand, the extreme of nationalization now gaining so generally in other countries, and on the other, the extreme of unregulated competition which is proving so disastrous both to the industries and to national welfare.

We recognize the fact that private industry has successfully developed the minerals of the United States to an extent never before approximated in the world; that the job on the whole has been done efficiently and without greater wastes or mistakes than were more or less inevitable under existing conditions of enforced competition and widely scattered ownership of the resources; that the record of the mineral industry in the United States warrants the presumption that it should continue to develop so far as possible under private initiative. However, we also believe that our mineral heritage is vested with a public interest in those specific conditions which are distinctly detrimental both to the public and to the industries themselves and which seem beyond the power of the industries themselves to remedy. To be frank, some of us do not think that the brains exist which are competent to produce a fool-proof plan broad enough to cover all the shifting variables of the problem, but, on the other hand, we are not content with a defeatist or drifting attitude, and hope that cooperative planning will produce some if not all of the desired results. Rugged individualism, with all its merits, seems ill-adapted to realize, unaided, the present political and economic requirements of conservation.

OBITUARY

CHARLES ROBERTSON

Charles Robertson is a well-known name in ecological and entomological circles. He was born at Carlinville, Ill., on June 12, 1858, and died on June 17, 1935. He was the son of the community doctor and after a selective course of study at various institutions began an intensive study of the flower and insect relations in an area twenty miles on a side around the city of Carlinville. This study was carried on intensively through a period of forty years and is perhaps the most detailed of any work of the kind ever done. It involved a minute study of the flowering plants and of their insect visitors together with the climatic conditions which govern their growth. In order that this might be done Robertson was called upon to describe some plants and many species of hymenoptera, diptera and lepidoptera. His collections are models of neatness and completeness. His type species are still within his collection. The results of his work are mainly presented in a series of articles entitled "Flowers and Insects," which appeared at irregular intervals for a period of thirty years, being printed in the *Botanical Gazette,* Transactions of the St. Louis Academy of Science and *Ecology.* His numerous descrip-

tions of many species of insects were published in the *Canadian Entomologist,* Transactions of the St. Louis Academy of Science, Transactions of the Philadelphia Academy of Science and other entomological publications. His bibliography contains one hundred and fifty-two titles. His last large publication was a book entitled "Flowers and Insects," which contains a summary of all his work. This volume came from the Science Press some four years ago. He was a member of the American Association for the Advancement of Science for a large number of years and he belonged to many of the learned societies of America and Europe. Robertson divided his time between the overseeing of a large number of farms which belonged to the family and his ecological work. He spent his winters in western Florida, where he owned considerable property and maintained a wildlife preserve. He was a life member of the St. Louis Academy of Science and was very intimately connected with Barnes, of Bloomington, Ill., and Trelease, of the University of Illinois. In entomological lines Robertson will long be remembered because of the great number of species of hymenoptera which bear his name and which because of the accuracy of his work will always bear the same name. Robertson probably did more to establish the study of ecology in the United States than any other one man.

H. B. PARKS

SAN ANTONIO, TEXAS

MARION DORSET

WITH the death of Dr. Marion Dorset on July 14, at his home in Washington, D. C., workers in the biological sciences lost an able colleague and friend. Dr. Dorset was widely known not only for his brilliant achievements but also for his generous recognition of work by others. His counsel on research problems was sought widely, and he was active in both administrative and laboratory work until a few days before his death, the immediate cause of which was coronary thrombosis.

Dr. Dorset was known especially for his investigations of hog cholera, during which he discovered an effective preventive-serum treatment now widely used. Other discoveries included research on the biochemistry of the tubercle bacillus, keeping qualities of meats, the development and testing of dips and disinfectants and extensive related work. Dr. Dorset is credited with being one of the first scientists to make chemical analyses of the tubercle bacillus. He also introduced, in April, 1934, a new tuberculin now used in official tuberculosis-eradication work conducted by the U. S. Department of Agriculture and cooperating states. His production of an effective and harmless fluid for marking federally inspected meats has saved the United States Government millions of dollars because of the greater economy of this method over the former practice of using tags.

As chief of the Biochemic Division, Bureau of Animal Industry, U. S. Department of Agriculture, Dr. Dorset likewise proposed many investigations which his coworkers carried out with results beneficial to agriculture and public welfare. One of these studies resulted in a rapid method of detecting pullorum disease in chickens, a discovery now widely used by poultrymen and a boon to the poultry industry. Dr. Dorset organized the system of federal inspection in establishments licensed by the government to manufacture serums, viruses, toxins and related veterinary biological products. He formulated also the laboratory procedures in the administration of the federal meat-inspection act. He was active also in the organization of the Federal Insecticide and Fungicide Board. He was a member of many scientific bodies and frequently presented papers at national and international meetings.

Born in Columbia, Tenn., in 1872, Dr. Dorset received the customary elementary education, after which he attended the University of Tennessee, from which he graduated in 1893 with the degree of bachelor of science. He then attended the Medical Department of the University of Pennsylvania for a year, after which he entered the U. S. Department of Agriculture as assistant chemist. One of his associates was the late Dr. E. A. de Schweinitz. Dr. Dorset meanwhile continued his scientific education at George Washington University, Medical Department, from which, in 1896, he received the degree of doctor of medicine. In 1904 he became chief of the Biochemic Division of the Bureau of Animal Industry, a position which he held until his death. Dr. Dorset was also awarded the honorary degree of doctor of veterinary medicine by Iowa State College. His scientific contributions had many applications in the livestock, meat and dairy industries and in public health. He devoted his life almost entirely to public service. After discovering anti-hog-cholera serum, he had the opportunity to acquire wealth through the manufacture and sale of this biological product, for which a large demand soon developed. But after receiving a patent on the discovery, he presented it to the government and to the public so that any person in the United States might use the method without payment of royalty. This act was typical of his generous nature and his desire that the results of his talents and labors should be widely useful.

J. R. MOHLER,

Chief, Bureau of Animal Industry

RECENT DEATHS

DR. ARTHUR D. LITTLE, engineering chemist, president of Arthur D. Little, Inc., Cambridge, Mass., died on August 1 at the age of seventy-one years.

GUSTAV LINDENTHAL, engineer, who was the builder of the Hell Gate Bridge and the Hudson and East River tunnels of the Pennsylvania Railroad, died on July 31. He was eighty-five years old.

DR. JAMES ARMITAGE EMERY, acting chief of the Biochemic Division in the Bureau of Animal Industry of the Department of Agriculture, died on July 28. He was sixty-eight years old.

DR. R. W. BROCK, since 1914 deputy minister of mines of Canada, dean of the faculty of applied science of the University of British Columbia, and Mrs. Brock were killed on July 30 when their plane nose-dived into trees. Dr. Brock was for seventeen years connected with the Canadian Geological Survey, for eleven years as geologist, and from 1908 to 1914 director. He was sixty-one years old.

SCIENTIFIC EVENTS

INTERNATIONAL CONGRESS FOR SCIENTIFIC MANAGEMENT

THE sixth International Congress for Scientific Management was opened in London by the Duke of Kent on July 15. At the closing session the Prince of Wales spoke on the work of the congress.

According to the London *Times,* previous congresses have been held in Prague, Brussels, Rome, Paris and Amsterdam, and this is the first time that the members have assembled in Great Britain. The purpose of the congress is to obtain papers on and discussions of the practical application of scientific management and also to provide opportunities for members to meet in an informal way people from other countries interested in the same problems as themselves. Sir George Beharrell, past president of the Federation of British Industries, was the chairman of the congress.

About 2,000 persons attended the meetings and some 200 papers prepared in advance by leading European authorities were printed and distributed to the members. The subjects covered a wide range and were discussed at six sectional meetings held simultaneously. A manufacturing section considered methods of controlling production from the four points of budgetary control, standards and forecasts: scientific methods applied to works management; production control to meet changes of product, of design or of process, and production management technique. The agricultural section discussed standardization as a factor in agricultural development. A section concerned with problems of distribution dealt with methods of organization as applied by manufacturers, wholesalers and retailers. An educational and training section considered methods of selection, education and training of personnel suitable for high administrative positions. There were also a development section and a domestic section.

NEW DIVISIONS IN THE FOOD AND DRUG ADMINISTRATION OF THE DEPARTMENT OF AGRICULTURE

Two new units, a Vitamin Division and a Pharmacological Division, have been organized in the Food and Drug Administration of the U. S. Department of Agriculture. Heretofore vitamin and pharmacological work has been carried on by small sections of the Drug Division, which have undertaken the necessary routine bioassays and vitamin assays of a limited number of official samples.

The pressing need for expansion of this work led to the decision last year to establish these research divisions even, if necessary, at the expense of a temporary reduction in regulatory operations. Accordingly, Dr. E. M. Nelson, associate chemist in the Bureau of Chemistry and Soils, has been appointed chief of the Vitamin Division of the Food and Drug Administration. He is under instructions to develop the new division, and it is hoped to increase the staff materially as the work of organization proceeds.

At present the scientific personnel of the division will consist of F. W. Irish, who has heretofore worked with Dr. Nelson and who has been a member of the staff of the vitamin section since 1931. New appointments to the division are Dr. Chester D. Tolle and John B. Wilkie, the latter by transfer from the Bureau of Chemistry and Soils. For the last two and a half years Dr. Tolle has been connected with the National Recovery Administration.

The Pharmacological Division is headed by Dr. Erwin E. Nelson, formerly of the University of Michigan, who was appointed principal pharmacologist of the Food and Drug Administration in January, 1935, under instructions to organize and develop this division.

Dr. Nelson has associated with him in the Pharmacological Division the following men who have qualified under civil service examinations and who have now reported for duty:

Dr. H. O. Calvery, senior pharmacologist, since 1927 has been assistant professor of physiological chemistry in the University of Michigan. The academic year 1932–33 he spent as Guggenheim Fellow in Europe, studying in Dresden and Prague. He has published extensively in the fields of embryonic and protein metabolism and en-

zyme activity. Dr. Calvery will be in charge of the biochemical work of the laboratory.

Dr. E. W. Wallace, since 1932 in direct charge of the teaching of pharmacology in the University of Chicago. His publications have been in the fields of pharmacology and experimental medicine.

Dr. J. M. Curtis has, for the past year, been National Research Council Fellow in anatomy at Yale University. His publications have been in the field of the chemistry and the isolation of the hormones of the sex glands.

Dr. G. E. Farrar, Jr., member of the Department of Medicine of the University of Michigan. His work has been especially in the field of the effect of heavy metals upon the formation of blood.

Dr. Lloyd C. Miller, physiological chemistry, has for two years been in the research laboratories of the Upjohn Company. His work has been in the fields of metabolism and the preparation and assay of sex gland products.

In addition to these newly appointed specialists, the original members of the pharmacological section of the Drug Division remain as a part of the new Pharmacological Division, including the following men:

W. T. McClosky, who has been in charge of the pharmacological section, will continue in charge of the biological assay work of the new division. His work in the field of biological assays, especially of pituitary gland, is widely recognized.

Dr. H. D. Lightbody joined the Food and Drug Administration in 1931. His publications have been especially in the fields of sulphur and carbohydrate metabolism.

Dr. Harold P. Morris was National Research Council Fellow in Nutrition at Minnesota from 1930 to 1931. He has since worked for the U. S. Bureau of Fisheries and the Bureau of Home Economics in the fields of food chemistry and food utilization.

Ewald Witt is a registered pharmacist.

Paul E. Tullar studied in the University of Michigan.

Herman J. Morris studied at George Washington University.

Dr. J. A. Matthews, after four years at the Bureau of Standards, joined the Department of Agriculture in 1934.

APPROPRIATIONS FOR THE MUSEUMS OF NEW YORK CITY

REPRESENTATIVES of the Metropolitan Museum of Art, the American Museum of Natural History, the New York Botanical Garden, the New York Zoological Society and the Brooklyn Institute of Arts and Sciences presented on August 1 to Budget Director Rufus E. McGahen and Assistant Director Leo J. McDermott of the Bureau of the Budget estimates of funds required for the year 1936. They called for an appropriation of $484,501 from the city, an increase of $85,356 over last year.

According to the account in *The New York Times* Dr. Herbert Winlock, director, and Frank Dunn, auditor, appeared for the Metropolitan Museum with a request for $398,757, an increase of $36,194.

Of the increase asked for by the American Museum of Natural History, $77,956 are for the salaries of attendants in the New York State Roosevelt Memorial building, which it is hoped will be opened next fall. $36,000 are for the wages of twenty-five additional attendants as being necessary for the reopening of at least five of the ten halls now closed in the museum.

The New York Botanical Garden asked for $254,968, an increase of $45,853, through Dr. Elmer D. Merrill, retiring director. The largest item of increase, $32,000, it was agreed, might be eliminated when Mr. McDermott pointed out that greenhouse repairs could probably be handled by the Public Works Administration. Other increases had to do with restoring the force of laborers to take care of the 400 acres that make up the gardens.

Philip N. Youtz, director of the Brooklyn Institute, asked for $269,723, an increase of $54,962. A schedule of $73,068, an increase of $5,816, was presented for the Aquarium, and one of $270,037, an increase of $8,554, for the New York Zoological Park in the Bronx. Both increases were based principally on supplies and equipment.

It had been proposed to open the Theodore Roosevelt Memorial Wing of the American Museum of Natural History on October 27, the seventy-seventh anniversary of Roosevelt's birth. Dr. Henry Fairfield Osborn, who retired from the directorship of the museum two years ago, in a statement made before sailing recently for Europe said that work on the memorial is not quite complete and an allocation of $100,000 to put the final touches on educational equipment for the museum is required. He was assured, however, that this sum would be forthcoming and that all financial matters relating to the subject would be settled on his return on September 8. The total cost of the structure to date is $3,500,000.

AWARD OF THE PRIZE IN PURE CHEMISTRY OF THE AMERICAN CHEMICAL SOCIETY

THE American Chemical Society award in pure chemistry will be presented to Dr. Raymond M. Fuoss, assistant professor of chemistry at Brown University, at the medal ceremony at the San Francisco meeting, which will be held from August 9 to 23.

Dr. Fuoss was selected for the most conspicuous research by a chemist under thirty-one years of age during the past year. Experimentation with electrolytic solutions in Dr. Charles A. Kraus's laboratory at Brown University led him to formulate what is said to be "the first comprehensive theory in that field."

Dr. Fuoss will read a paper on his work before the Division of Physical and Inorganic Chemistry. He is one of the younger members of a school of chemists, now in its third generation, founded at the University of Kansas in 1896 by Dr. Charles A. Kraus, Professor Hamilton P. Cady and Dr. Edward Curtis Franklin. Dr. Franklin, emeritus professor in Stanford University, is honorary chairman of the San Francisco meeting committee.

Since his graduation from Harvard University in 1923, Dr. Fuoss has studied at the University of Munich; in Professor Debye's laboratory at Leipzig, and under Professor Fowler at Cambridge. He has also completed graduate work at Brown and Harvard Universities, carried on industrial research and assumed charge of the Newport Rogers Laboratory at Brown University in Dr. Kraus's absence. He has published twenty-one papers in scientific journals, seventeen since 1922. He was born in Bellwood, Pa.

Dr. Kraus has given the following description of Dr. Fuoss's work:

> Dr. Fuoss has developed a theory of electrolytic solutions which applies to solvents other than water, such as ammonia. On coming to Brown, he undertook researches into the difficult and somewhat unpromising problem of electrolytic solutions. On the experimental side, the field of electrolytic solutions was in a very unsatisfactory state. Adequate data for testing theoretical relationships were available only for water solutions.
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> In the case of solutions in solvents other than water, the data were, in general, not sufficiently reliable to permit a definite answer to the question as to whether or not mass action effects actually exist in solutions of ordinary salts in such media. No serious attempt has been made to provide a theory for solutions of this type.
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> Striking at the root of the problem, Dr. Fuoss measured the conductance of solutions. He showed for the first time that conductance of an electrolyte in a nonpolar medium approaches a limiting value rather than zero. On the basis of his experimental results, he proceeded to develop an adequate theory to account for the observed properties of an electrolytic solution as a function of the dielectric constant of the medium, temperature, and certain other constants of the medium and the solute. He likewise devised new methods for mathematical analysis of the various types of conductance curves. These methods have proved invaluable in analyzing the results of conductance measurements. It is not too much to say that as a result of this work we now have, for the first time, a comprehensive theory of electrolytic solutions which, at lower concentrations, applies to all solvent media and to all electrolytes.
>
> In other words, we are now able to predict the properties of a solution of a given electrolyte in a given solvent medium provided that certain fundamental physical constants of the electrolyte and the medium are known.

The $1,000 award in pure chemistry was founded by A. C. Langmuir, of Hastings-on-Hudson, N. Y., to reward "the accomplishment in North America of outstanding research in pure chemistry by a young man or woman under thirty-one years of age, preferably working in a college or university." "Outstanding research" is construed to mean work of unusual merit for an individual on the threshold of his career. Members of the Committee on Awards of the American Chemical Society award in pure chemistry are: Professor Edward Bartow, of the University of Iowa, president-elect of the society; Professor Homer B. Adkins, Dr. John Johnston, Dr. Ralph E. Gibson, Dr. Frank C. Whitmore, Dr. W. H. Carothers and Edward Mack, Jr.

THE DIRECTOR OF THE NEW YORK BOTANICAL GARDEN

AT a special meeting of the Board of Managers of the New York Botanical Garden, held at the office of the president, Henry W. de Forest, Dr. Marshall Avery Howe was elected director of the garden, effective on October 1. He succeeds Dr. Elmer Drew Merrill, director since January 1, 1930, who has resigned to accept a call to head the eight botanical units of Harvard University. Dr. Howe has been a member of the scientific staff of the Botanical Garden for thirty-four years, serving as assistant director for the past twelve years and as acting director for several short periods. He has seen the garden develop from little but an ambitious plan in the mind of the first director, the late Dr. Nathaniel Lord Britton, and his co-workers to its present rank as one of the three leading institutions of the world devoted to the advancement of the plant sciences, with four hundred acres of land, more than one hundred people on its regular payrolls, about 1,800,000 specimens in its herbarium, 45,000 bound volumes in its library, and notable floral and horticultural displays out of doors and under glass extending throughout the year.

Dr. Howe is a graduate of the University of Vermont, of which state he is a native. After a short period as submaster of the Brattleboro High School, he accepted, in 1891, an appointment as instructor in cryptogamic botany in the University of California. In 1896, he came to New York for graduate studies at Columbia University, from which he received the degree of doctor of philosophy in course in 1898. After three years as a member of the botanical staff of Columbia University, he became assistant curator of the New York Botanical Garden in 1901, advancing to curator in 1906, and to assistant director in 1923. Dr. Howe has made field expeditions to Nova Scotia, Newfoundland, Bermuda, Florida, the Bahama Islands, Cuba, Puerto Rico, Jamaica and Panama. He has made special studies of the plant life of the sea, in which field he is an acknowledged authority. Since 1912, his writings and lectures have emphasized the importance of lime-secreting sea-plants in reef-building and land-forming, an activity that has long been

credited almost exclusively to lime-secreting animals, the corals. Recent investigations show that in many parts of the world the plants have played a greater part in land-building than have the corals.

Dr. Howe has long taken an active personal interest in horticulture, specializing particularly in dahlias, irises and peonies. The dahlia border at the Botanical Garden, under his direction for the eighteen years of its existence, with four or five hundred of the newer and better varieties as well as a few of the older ones, attracts thousands of visitors each season, and has done much to educate amateurs and professionals in the advances in this field.

He has been editor of ***Torreya, The Bulletin of the Torrey Botanical Club,*** the monthly ***Journal*** of the New York Botanical Garden and of various other publications of the garden. He is a fellow and at the present time president of the New York Academy of Sciences, a member of the National Academy of Sciences and of various other scientific societies. In 1919, his alma mater conferred upon Dr. Howe the honorary degree of doctor of science. It is expected that under his directorship the advances made by Dr. Merrill on the substantial foundations laid by Dr. Britton during his thirty-three years of leadership will be effectively conserved and continued.

SCIENTIFIC NOTES AND NEWS

DR. IVAN PAVLOV, professor of physiology at the University of Leningrad, is host to the 850 foreign physiologists and biologists, representing thirty-seven countries, who are expected to attend from August 8 to 17 in Moscow and Leningrad the International Congress of Physiology, of which he is president. Dr. Pavlov attended the International Neurological Congress, which opened in London on July 29. Last year, on the occasion of his eighty-fifth birthday, the Soviet Government awarded to him an annual pension of 20,000 rubles. A fund of 1,000,000 rubles was also made available for extensions to his laboratories in Leningrad.

DR. H. S. REED, professor of plant physiology in the Citrus Experiment Station of the University of California, has been awarded the Bronze Medal of the Société Nationale d'Acclimatation de France, in recognition of his work in botany and of collections of plants he has made for the Paris Museum of Natural History.

DR. OSKAR BAUDISCH, research chemist and technical consultant of the Saratoga Springs Commission, who has been carrying on a series of investigations at the Biochemical Institute, University of Stockholm, Sweden, of which Dr. H. von Euler is director, has recently been awarded the gold Scheele Medal for outstanding biochemical research by the Swedish Chemical Society. This is the second time this medal has been awarded to a United States citizen. The late Professor Otto Folin was awarded the medal some years ago.

DR. LEROY U. GARDNER, director of the Saranac Laboratory for the Study of Tuberculosis, Saranac Lake, N. Y., received the Trudeau Medal of the National Tuberculosis Association at the annual meeting in Saranac Lake on June 24. The award was made for his work on the pathology of tuberculosis, notably that dealing with the relation between tuberculosis and silicosis.

THE Medal of Achievement of the Poor Richard Club of Philadelphia was recently awarded to Dr. John A. Kolmer, professor of medicine at Temple University, in recognition of his work on poliomyelitis vaccine.

W. T. ASTBURY, of the department of textile physics at the University of Leeds, has been awarded the Actonian Prize of 100 guineas. This award of the Royal Institution is made every seven years for the best essay "illustrative of the wisdom and beneficence of the Almighty in some department of science."

THE honorary degree of doctor of science was conferred on Dr. Walter Robert Parker by the University of Michigan at its recent commencement. For twenty-eight years Dr. Parker was professor of ophthalmology at the university; since 1933 he has been professor emeritus.

HONORARY degrees were conferred recently by the University of Belfast on Professor T. G. Moorhead, regius professor of physic, Trinity College, Dublin; on Dr. T. Carnwath, senior medical officer, Ministry of Health; and on Major-General W. P. Macarthur, deputy director general, Army Medical Services. The degree of D.Sc. was conferred on J. B. Parke for work on the viscosity of emulsions.

DR. GUY W. SMITH, associate professor of mathematics at the University of Kansas, has been promoted to a full professorship.

ROWLAND J. CLARK has been appointed associate professor of milling industry at the Kansas State College. His principal work will be in testing wheats and flours for their various characteristics as influenced by varietal factors, environmental conditions, milling procedure, and to relate these to their utilization by the milling and baking industries.

DR. IVES HENDRICK, of the Harvard University Medical School, has been invited by the Graduate School of

Duquesne University, Pittsburgh, Pa., to give a course for graduate social workers from August 1 to September 4 on "The Psychoanalytic Approach in Social Work." The course consists of lectures, colloquia and conferences.

W. Warren Longley, a graduate student at the University of Minnesota, has been elected to an instructorship in geology at Dartmouth College. Mr. Longley has charge of a prospecting party in the Canadian north country this summer.

D. Ananda Rao, principal of the Agricultural College, Coimbatore, India, has been appointed director of agriculture in succession to S. V. Ramamurthi.

The following appointments were recently made in the University of Sheffield: J. MacD. Croll, to be lecturer in bacteriology; Mansergh Shaw, to be assistant lecturer in mechanical engineering, and Dr. Edward S. Duthie, to be a demonstrator in pathology.

Nature reports that the following appointments have been made at the University of Cambridge: E. Farmer, of Trinity College, reader in industrial psychology; E. G. Chalmers, of Clare College, assistant director of research in industrial psychology; P. Graffa, of King's College, assistant director of research in economics; Dr. J. K. Roberts, of Trinity College, assistant director of research in colloid science; Dr. W. A. Wooster, of Peterhouse, lecturer in mineralogy and petrology; E. T. C. Spooner, of Clare College, lecturer in pathology; G. C. Grindley, lecturer in experimental psychology; N. Dean, of Trinity Hall, lecturer in estate management; C. Culpin, of St. John's College, demonstrator in agricultural engineering; Dr. J. D. Cockcroft, of St. John's College, lecturer in physics; P. I. Dee, of Sidney Sussex College, lecturer in physics; Miss A. C. Davies, of Newnham College, lecturer in physics; Dr. M. L. E. Oliphant, of St. John's College, assistant director of research in physics; Dr. W. B. Lewis, of Gonville and Caius College, demonstrator in physics.

Dr. Z. P. Metcalf, professor of zoology at the North Carolina State College of Agriculture, has been elected visiting professor of zoology at Duke University for 1935–36.

Dr. Esmond R. Long, director of the laboratory of the Henry Phipps Institute of the University of Pennsylvania, has been made director of the institute. Dr. Charles J. Hatfield, formerly director, will be associate director and chairman of the board of directors in charge of the institute. Dr. Henry R. M. Landis will have the title of associate director in charge of the clinical and sociological departments.

As has already been reported in Science, Dr. Marshall Avery Howe was elected director of the New York Botanical Garden at a special meeting of the Board of Managers. At the same meeting Dr. H. A. Gleason was appointed as deputy director, though retaining his present title of head curator. H. de la Montagne, assistant treasurer and business manager, was appointed assistant director.

Dr. Thomas C. Grubb has been appointed a member of the professional staff of the Illinois State Department of Health and will conduct research in the control and prevention of disease.

The Council of the Royal Society, London, has awarded Dr. M. N. Saha a sum of £150 for research on the thermal ionization of gases. Dr. Saha, who has also been awarded the Carnegie Research Scholarship for the year 1935–36, will leave for America in September. He expects to undertake a world tour before returning to India.

Three members of the staff of the College of Natural Science of Yenching University, China, have received grants from the China Foundation of $500 each toward the support of research projects. These are: Dr. Tsai Liu-sheng, for continuing his work on the preparation of activated charcoal from Chinese raw materials; Chang Tso-kan, for research on the herpetology of Kiangsi and Chekiang, and Chang Tsung-ping, for a study of the insects of the pear tree in Ting Hsien.

The Committee on Scientific Research of the American Medical Association has awarded to Dr. Frederick A. Fender, of the department of surgery of the Stanford University School of Medicine, a grant to be used for the further study of the effects of prolonged electrical experimental stimulation of certain components of the nervous system. Dr. Wallace M. Yater, professor of medicine, Georgetown University School of Medicine, has received a grant to carry on research on the histopathologic basis of "bundle-branch block."

Wallace Fetzer, Ph.D. (Minnesota, 1934), has gone to Colombia, South America, where he will work on gold projects for the Colombian government, with whom Dr. Philip Merritt, of Columbia University, is also doing geologic work.

Dr. G. W. Martin, professor of botany in the University of Iowa, has sailed for the Panama Canal Zone. He is planning to join Dr. Woodson, of the Missouri Botanical Garden, at Balboa, and thence to explore sections of the island and mountain areas of Panama, the Canal Zone and the Santa Marta Mountains in Colombia. The expedition will be devoted to collecting Myxomycetes and Basidiomycetes.

Dr. Victor E. Levine, of the Creighton University School of Medicine, is now in the Arctic on his third

trip for the purpose of continuing his medical and biological studies of the Eskimo. He will confine his observations to the region north of Nome, to Teller, Cape Prince of Wales, Deering, Kiwalik, Shishmaref, Kotzebue, Point Hope, Point Lay, Wainwright and Point Barrow. At Wainwright and Point Barrow he will take the opportunity of determining the extent and severity of the recent epidemic of influenza among the Eskimos.

DR. ELMER D. MERRILL, director of the New York Botanical Garden, president of the section of taxonomy and nomenclature of the sixth International Botanical Congress to be held at Amsterdam from September 2 to 7, will sail for Europe on August 16. He will serve as an official delegate representing the United States Government and chairman of the delegation, and will also represent the National Academy of Sciences, the American Association for the Advancement of Science, the New York Academy of Science, the New York Botanical Garden and the Bishop Museum of Honolulu.

DR. B. A. HOUSSAY, professor of physiology at the University of Buenos Aires, has, according to the *Journal* of the American Medical Association, been invited to deliver the Dunham lecture at Harvard University, the Hanna lecture at Cleveland, the Harvey lecture at New York and other lectures at the Academy of Medicine of California and at Stanford University.

THE fifth Congress of Biological Chemistry will be held at Brussels from October 23 to 25. The general secretary is M. R. Fabre, 149 rue de Sèvres, Paris.

THE annual meeting of the American Association of Agricultural College Editors will be held at Cornell University on August 20, 21 and 22. Delegates are expected to attend from nineteen states and from the Department of Agriculture at Washington.

THE *Journal* of the American Medical Association reports that the first Congress of Human and Animal Brucellosis met in Avignon, on June 11, to discuss the relations between the different forms of brucella infections in man and those of animals. The subjects discussed were prophylaxis and treatment of undulant fever, differentiation of the various types of brucella infection, epidemiology of brucella infections in relation to the dairy industry, and legislation on the subject of undulant fever.

THE Alpha Chi Sigma banquet, at the American Chemical Society convention in San Francisco, meeting from August 19 to 23, will take place on Tuesday, August 20, at 7 P. M., at the Capri Italian Restaurant, Oakland. Wm. Higburg, in charge of the professional branch of the fraternity, will be present. The convention program calls for a trip to the campus of the University of California on Tuesday afternoon, making the fraternity dinner site quite convenient for all who cross the bay for the inspection. Advance reservations should be sent to R. K. Witt, 2535 Le-Conte Street, Berkeley. Arrangements for reservations will also be available at the registration desk of the American Chemical Society. The dinner will be under the auspices of the San Francisco professional chapter of the fraternity. The third semi-annual professional conference of the branch will be held either preceding or following the banquet.

ORGANIZATION of the Oceanographic Society of the Pacific was effected recently at a meeting at the Scripps Institution of Oceanography. The meeting was attended by about sixty scientific men from many points along the Pacific Coast. Following the meeting a series of twelve communications on oceanographic activities along the coast was read. Dr. T. Wayland Vaughan, director of the Scripps Institution, was named president of the new organization; Dr. C. McLean Fraser, of the University of British Columbia, vice-president; Dr. C. L. Utterback, of the oceanographic laboratories of the University of Washington, secretary-treasurer; while the members-at-large are W. L. Scofield, California Fisheries Laboratory, Terminal Island, and Beno Gutenberg, California Institute of Technology. The meeting was held under the joint auspices of the Committees on the Oceanography of the Pacific of the United States and of Canada.

THE one hundred and third annual meeting of the British Medical Association was held in London from July 19 to 23 and will continue in Melbourne in September. The scientific discussions, many of which are said to be of considerable public importance, will be held in Melbourne under the presidency of Lieutenant-Colonel Sir James Barrett, deputy chancellor of the University of Melbourne and consulting surgeon to the Victorian Eye and Ear Hospital. Many social functions will take place during the meeting. The annual representative meeting at which specially appointed representatives from each local unit of the association throughout the empire attended and which deals with the business affairs of the association and with matters of general medico-political interest, was held at the house of the association in Tavistock Square, London.

PRESIDENT ROOSEVELT has recently ordered the Science Advisory Board to be continued until December 1, 1935. The board was originally appointed on July 31, 1933, for a two-year term to advise the President and departmental secretaries in regard to scientific matters. It now consists of fifteen members.

THE United States Civil Service Commission announces open competitive examinations for the positions of principal engineering draftsman, $2,300 a year; senior engineering draftsman, $2,000 a year; engineering draftsman, $1,800 a year; assistant engineering draftsman, $1,620 a year. Optional branches include architectural, civil, electrical, mechanical and structural engineering.

THE Rockefeller Foundation has appropriated for work at the University of Michigan for study of the application of spectroscopic methods to medical problems, under the general direction of Professor L. H. Newburgh and Professor H. M. Randall, the sum of $14,000 and funds not to exceed $5,000 annually for a five-year period to end June 30, 1940, for special research in the physiology of respiration, under the direction of Dr. Robert Gesell.

GEORGE H. DERN, Secretary of War, has announced approval by the National Forest Reservation Commission of 949,804 acres of land for purchase for the national forests at a cost of $3,493,328. The approved purchases include 407,462 acres in the southern forest service administrative region, 217,373 in the northeastern region, 324,679 acres in the Lake and Upper Mississippi states and 200 acres in California.

DISCUSSION

GRANTS IN SUPPORT OF RESEARCH ON THE BIOLOGICAL EFFECTS OF RADIATION

IN previous statements in this journal,[1] indications have been furnished regarding grants in support of research on the effects of radiation on organisms. During the period of somewhat more than five years, the Radiation Committee of the National Research Council has been able to make these grants as a result of contributions made by the General Education Board, the Commonwealth Fund and certain manufacturers of radiation equipment and scientific apparatus and materials. Through a contribution made recently by the Rockefeller Foundation to the National Research Council, the Radiation Committee announces a continuation of a limited program in support of research on the biological effects of radiant energy. The new program becomes effective after July 1, 1935, and it is hoped that in this new program the projects supported may be those directed primarily toward obtaining a broader basis of quantitative data in this field, that is, studies along such lines as the fundamental physiological and developmental responses of cells and tissues, metabolism in the broadest sense, significant biological products, relevant absorption and emission spectroscopy. Grants will be made annually. In making these grants, stress will be placed upon the fundamental scientific promise of the project and the facilities and cooperation available for the work. Funds totaling $75,000 are available for this purpose during a three-year period. This includes a special allotment for mitogenetic radiation research during 1935–36, and it also provides for the continuation of a few projects begun during the previous five-year period. The possibility also exists, through the cooperation of interested industrial corporations, for the loan of certain types of apparatus. Applications for grants should include an adequate statement of the status of the problem or project, the extent of the support received or promised by the university or institution with which the applicant is associated, and the character of the apparatus available or obtainable for the work.

[1] W. C. Curtis, SCIENCE, 73: 643–645, June 12, 1931; SCIENCE, 69: 9–10, January 4, 1929.

The conditions under which grants of money or apparatus may be made are essentially the same as those made by the Committee on Grants-in-Aid of the National Research Council, and are in general, as follows:

1. Grants will cover such expenses as apparatus, materials and supplies, technical assistance, and, to a limited extent, field expenses.
2. Ordinarily, grants will not be made for any part of the personal salary of the grantee, for expenses of publication, for the purchase of books or for travel in attendance upon scientific meetings.
3. In general, preference will be given to the support of investigations, (a) requiring a moderate allotment, (b) from which definite results may be expected with the aid of the grant, (c) which are supported in part by the institution with which the applicant is associated, and (d) for which it is reasonably certain that the facilities are available or procurable, or in which cooperation is arranged between the biological and physical interests.

It is expected that allotments for 1935–36 will be made in late August. Those planning to apply for grants should request application forms from the Division of Biology and Agriculture, National Research Council, 2101 Constitution Ave., Washington, D. C. The applications, together with any supporting documents, should be sent promptly, preferably by August 10, to the Division of Biology and Agriculture.

B. M. DUGGAR,
Chairman, Committee on Radiation.

A WIDE-SPREAD ERROR RELATING TO THE PYTHAGOREANS

The "Pythagorean symbol" is defined in some of our dictionaries as the hexagram. This is done, in particular, in Webster's "New International Dictionary," second edition, 1935, under the entry "hexagram," as well as in the "Century Dictionary," 1906. On the contrary, recent writers on the history of Greek mathematics, including M. Cantor and T. L. Heath, call attention to the fact that the star-pentagon is said to have been used by the Pythagoreans as a symbol of recognition between members of the same school and to have been called by them Health, according to Lucian and the scholiast to the *Clouds* of Aristophanes; *cf.* "Manual of Greek Mathematics," by T. L. Heath, 1931, page 108. According to Murray's "English Dictionary," under the entry "Pythagorean," 1909, the capital Greek letter upsilon was used by the Pythagoreans as a symbol of the two divergent paths of virtue and of vice.

The construction of the regular pentagon is related to what is now commonly called the "golden section," *viz.*, the division of a straight line segment into extreme and mean ratio. Therefore, it is of great historical interest to know whether the early Pythagoreans were familiar with this section. The construction of the regular hexagon, on the other hand, is very much simpler and does not involve the solution of a quadratic equation. Hence the assertion that the Pythagorean symbol is the hexagram instead of the pentagram is not only misleading but it also fails to exhibit the mathematical advancement of the Greeks at about the time of Pythagoras. It is natural to assume that the symbol of recognition among the Pythagoreans was selected because it involves something that was then regarded as somewhat abstruse rather than something that was even then regarded as elementary.

G. A. Miller

University of Illinois

MORE THAN TWO PRE-CAMBRIAN GRANITES IN THE CANADIAN SHIELD

In the May 24, 1935, issue of Science Professor Andrew C. Lawson has objected to a statement of mine that "from geologic evidence, the Laurentian, Algoman and Killarney granites appear to be so different in age that radioactive age determinations should distinguish between them."[1] This statement of the distinction between the Algoman and Killarney granites and statements of like import in most of the text-books on historical geology which have appeared in the last dozen years are characterized as dogmatic, and Professor Lawson calls upon me to set forth the geologic evidence that these granites are of different age. Professor Lawson's view is that "the Killarney granite is the Algoman granite."

[1] Science, February 22, 1935, p. 186.

The point urged in the address under criticism was that the methods of determining the age of igneous rocks by radioactive disintegration are now apparently becoming sufficiently accurate to raise hopes of differentiating the granites of the Canadian Shield on a time basis and of obtaining a few reliable dates in the pre-Cambrian time scale between which may be fitted in the various geologic events and rock formations. There seem to be enough different granites to make this possible. Investigations along the lines advocated should give us the facts of the case, whatever they may prove to be, and Dr. Lawson's view that the Algoman and Killarney granites are of the same age would be put to the test and its correctness or incorrectness presumably determined. The spirit of the address to bring to bear new evidence of seemingly great value in discrimination to check current views of correlation seems to me not one of dogmatism, but the reverse of it. It calls attention to an additional method of appraisal.

Belief was expressed in the existence of three granites of widely different age in the Canadian Shield. For convenience the three familiar names, Laurentian, Algoman and Killarney, were used. One should not be the slave of these names, however, in considering the main problem. Dr. Lawson asks for geologic evidence. Some of this evidence may be listed as follows.

I. Granitic rocks older than the Timiskaming system have been reported by many observers as the result of studies covering a period of many years. To be sure, most of the granite originally called Laurentian is now thought to be of later date, but the later studies by no means eliminate the Laurentian granites as a whole. Pebbles of a granite older than the Timiskaming are found as important constituents of the conglomerates in the lower part of the Timiskaming series.[2]

II. Important granitic intrusions cut through the Timiskaming succession in large volume without penetrating the overlying Cobalt system of strata, which is separated from the Timiskaming by a great unconformity. These masses of granite were intruded, therefore, after deposition of the older Timiskaming and before deposition of the younger Cobalt formations, for whose basal conglomerates they have furnished numerous pebbles.[3]

III. In certain other areas there is granite which is younger than the Cobalt. For this I will quote Dr. Lawson himself, who comments on a report on the

[2] H. C. Cooke, W. F. James and J. B. Mawdsley, Geol. Surv. of Canada, Mem. 166 (1931), p. 56 and pp. 104–106.
[3] Geol. Surv. Canada, Mem. 166, pp. 108–138.

Sault Ste. Marie area by R. G. McConnell as follows: "The young granite clearly cuts the whole of the Huronian, including the latest Cobalt rocks. It also cuts certain quartz-diabase dikes in the Huronian, but is older than the olivine diabase dikes of the region. It is lithologically similar to the Killarney and is correlated with it. This appears to settle the question of the relation of the Killarney granite to the Cobalt series and proves its post-Cobalt age."[4]

Just what is the proper use of the term Algoman is another question which may be left to others better qualified to judge. Dr. Lawson himself proposed the name Algoman and first applied it to the post-Seine granites in western Ontario.[5] He believed it to be post-Huronian in age and has since referred to it as post-Huronian "by definition." Unfortunately the post-Huronian age of the granites in the Seine River area is based on the assumed equivalence of the Seine and the Huronian—an unproved supposition. Perhaps ultimately it may be found advisable to avoid confusion by adopting new names in the place of one or more of the three now so commonly used, or by redefining the present terms. Whichever granite Dr. Lawson prefers to call Algoman, there seems to me sufficient justification for the contention that there are at least three granites in the Canadian Shield of widely different age.

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TRANSFORMATION OF COORDINATION AFTER CROSSING THE ACHILLES TENDONS IN THE FROG

In 1934 W. Manigk[1] reported observations which, if confirmed, would overthrow the accepted theories of reciprocal innervation. He found that frogs whose hind legs had been sewn together in such a way that only the feet were movable, walked with a characteristic front-leg–hind-foot rhythm. This rhythm persisted after excision of all the extensor muscles of the feet except the gastrocnemii. He then crossed the distal ends of these muscles to the opposite feet in such a way that contraction of the right gastrocnemius would extend the left foot, while contraction of the left gastrocnemius would extend the right foot. The flexors of the feet were left unchanged.

Manigk stated that there was no difference between the walking of frogs so operated and frogs with uncrossed gastrocnemii. Both groups of animals walked with the same front-leg–hind-foot rhythm. From this fact he concluded that the crossing of the gastrocnemii in some way brought about a transformation in the innervation rhythm of these muscles, which caused them to cease acting as the antagonists of the flexors of the same side and to take on the function of antagonists of the flexors of the opposite side.

The writer repeated Manigk's experiments and obtained the same results. However, further investigation failed to substantiate his conclusion that the transposition of the gastrocnemius muscles occasions a change in their innervation rhythm. It was found that *denervation* of the crossed gastrocnemii does not affect in any way the walking behavior of the frogs. Since this is the case, we must conclude that the crossed un-denervated gastrocnemii do not produce foot movement. In view of this fact, it is obvious that no conclusion as to a change in the innervation rhythm of the extensors can be drawn from Manigk's experiment. Extensive studies of the movement mechanism revealed that the observed foot extension was produced by other muscles in the leg and thigh acting through a lever system introduced by the crossing operation.

Further evidence against Manigk's conclusions is furnished by the following experiment. In a number of frogs all the muscles moving one hind foot, except the gastrocnemius, were excised and the two legs were sewn together. The distal portion of the gastrocnemius was transposed in such a way that contraction of the muscle now produced flexion of the foot instead of extension, as is normally the case. The righting response of animals so operated was compared with that of control animals whose legs had been sewn together. If a control frog is placed on its back, both hind feet extend as the animal turns over. If now a frog with one of its legs operated in the manner just described is placed on its back, the operated foot is seen to flex strongly when the unoperated foot extends in the righting reaction. These results show that, in spite of its transposition, the gastrocnemius still contracts when it would have contracted had its location not been changed. This experiment furnishes positive evidence that under certain conditions at least, the transposition of the distal end of the gastrocnemius does not affect its innervation rhythm.

On the basis of these observations we must conclude that Manigk has not demonstrated any change in innervation rhythm of the gastrocnemii as a result of their transposition and that such a transformation is extremely unlikely. There, therefore, seems to be no necessity for a revision of the existing theories of reciprocal innervation.

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[4] Andrew C. Lawson, *Bull. Geol. Soc. Amer.*, Vol. 40, p. 366, 1929.

[5] Andrew C. Lawson, Geol. Surv. of Canada, Mem. 40 (1913), pp. 103–109.

[1] Wolfgang Manigk, *Pflüger's Arch.*, 234: 176–181, 1934.

WELL RECORDS SOUGHT

THE writer is making a mineralogical and chemical study of the saline "black waters" of western New York State. These waters are connate in the Niagara (Silurian) limestone. For the past several months he has been collecting well records but is only interested in those wells actually reporting black water when the Niagara limestone was contacted.

In an effort to obtain as many well records from western New York State as possible, he is asking all those who might have such records in their files to forward them to the writer, care of the Buffalo Museum of Science. Receipt of same will be greatly appreciated. Exact location of the well, the surface elevation and depth at which the black water was encountered are the only data that need be given.

A. E. ALEXANDER

BUFFALO MUSEUM OF SCIENCE
NEW YORK

SCIENTIFIC BOOKS

SOME NEW BOTANICAL TEXT-BOOKS

The Plant Kingdom: A Text-book of General Botany. By WILLIAM H. BROWN. ix + 869 pp. 1,040 figs. Ginn and Company, Boston. 1935. $3.50.

THE old order is slowly changing in botanical texts, yielding place to new. This is happily reflected in the volume by Brown. While the mold in which it is cast is essentially similar to that of previous works on the subject, this book has certain distinct and outstanding merits. In the first place, modern discoveries are given due consideration. For example, photoperiodism, growth-regulating hormones and recent suggestions with regard to water movement are succinctly discussed. In dealing with heredity, the usual ratios in the four-o'clock and the pea are explained; but in addition the inheritance of sex in plants and of color characters in corn and wheat is also described.

The morphological treatment afforded the organs of the plant is unusually complete, both in the scope of the descriptive matter and in the abundance of accurate and artistic illustrations. Throughout the book the illustrations are excellent, and, in the first part especially, nearly all are original—a very refreshing phenomenon. The chapter on plant geography, and the earlier chapters generally, serve as reminders that there are plants in the tropics, though the time-honored —and somewhat time-worn—representatives of higher latitudes are by no means neglected.

This is a large book, and the range of material taken up in most of the groups—the algae and fungi, for instance—is much greater than usual. And here again the modern work is given consideration.

A novel feature is the adequate discussion allotted to certain fossils that are now coming to be regarded as links in the chain of evolution. Thus among the lower Pteridophyta, the Psilophytales, including *Rhynia, Hornea, Psilophyton* and *Asteroxylon,* are amply treated; among the higher forms the Calamitaceae and Sphenophyllaceae and *Lepidodendron* and *Sigillaria* are considered. Similarly, among the Spermatophyta the Cycadofilicales and the very important *Cycadeoidea, Williamsonia* and *Williamsoniella* are taken up in some detail.

One might desire, in a book of this size, a better indication of the orders, families and interrelationships of the Angiosperms—a feature that is largely omitted.

The style is simple, direct and easy to follow throughout, and the manner of presentation easily understandable. This book is a distinct contribution in its thoroughness and completeness.

A Textbook of General Botany. By GILBERT M. SMITH, JAMES B. OVERTON, EDWARD M. GILBERT, ROLLIN H. DENNISTON, GEORGE S. BRYAN and CHARLES E. ALLEN. x + 574 pp. 429 figs. 3d edition. The Macmillan Company, New York. 1935. $3.50.

THE third edition of the Wisconsin text is larger than many other recent botanical texts, for two reasons: The discussions go into considerable detail, and certain topics omitted or barely mentioned in other books are included. The usual material is discussed in a very thorough fashion. In the chapter on "Inheritance and Variation," for example, the rôle of chromosomes in heredity, characters and genes, linkage and crossing over and their physical basis, the kinds of variations in plants, polyploid series and other variations in chromosome numbers, and chromosome fragmentation are all rather carefully considered. Similarly, in the chapter on "Floral Types and the Families of Angiosperms," nineteen families are characterized and illustrated.

Among the less usual topics included is "The Geographic Distribution of Plants in North America." Tundra, forests, grasslands and deserts are described. The forest types are taken up in some detail.

The subject of "The Economic Significance of Plants" is reviewed under various topics, such as the plant parts used commercially, the geographical distribution of crop plants, medicinal plants, forestry, weeds and plant diseases. It is evident that this text treats of numerous subjects that are beyond the scope of most books on general botany.

The book is conservative. Recent work is not neglected; it is in many cases almost unnoticeably incorporated in the general body of knowledge presented;

and no particular deference is paid to the spectacular features of the science. The style is readable and yet cautious. The illustrations are clear and mostly original. This work rather suggests a stout ship, of ample tonnage, neither particularly stream-lined nor remarkably high speed, but thoroughly sound and seaworthy, well ordered and well wrought.

Botany: Principles and Problems. By EDMUND W. SINNOTT. xix + 525 pp. 310 figs. 3d edition. McGraw-Hill Book Company, New York and London. 1935. $3.50.

IN some ways at least, this is the most modern of the current series of text-books. Several features are striking. One is the inclusion of a chapter on "Development and Morphogenesis (Experimental Morphology)." These terms are used in the broadest sense, and the chapter represents a digest of more recent research in botany, incorporated with some older discoveries. The subjects considered include, among others, polarity, wound hormones, auxin, etiolation, photoperiodism, mitogenetic radiations and metabolic gradients. The chapter on plant evolution contains references to Fernald's taxonomic and ecological work; to many, convincing evidence for plant evolution may be found in a study of the distribution of related species and varieties.

The plant kingdom is divided into three great groups: the Thallophytes, the Bryophytes, and the Vascular Plants or Tracheophytes. The group of Vascular Plants in turn is subdivided; several primitive forms, including the extinct *Rhynia* and *Asteroxylon,* are first considered, together with the living *Psilotum* and *Tmesipteris,* which may be related to them. From these primitive forms three lines of development are postulated: the Lycopsida, including the living *Lycopodium, Selaginella* and *Isoetes,* and the extinct *Lepidodendron;* the Sphenopsida, including *Equisetum* and the Calamites; and the Pteropsida, including the Ferns and also the Gymnosperms and Angiosperms, which are thought to have been derived from them.

Although the third edition of this text is considerably larger than the previous ones, it is still not one of the larger books and its discussions are in most cases brief. Nevertheless, much ground is covered. In the Ferns, for instance, reference is made to *Marsilia;* and in the Gymnosperms, to the Cycadofilicales, the Bennettitales, *Ginkgo,* and the Gnetales. Among the Angiosperms the evolutionary tendencies are pointed out, and some of the more important orders are briefly considered.

The "questions for thought and discussion," at the close of the chapters, for which this book has always been known, now number 782. The style is not so simple as in some of the other texts and is more literary. This book is a modern presentation, scientifically accurate, pedagogically sound, and valuable.

An Introduction to Plant Life. By CARL L. WILSON and JULIA M. HABER. xiv + 493 pp. 316 figs. Henry Holt and Company, New York. 1935. $3.00.

ACCORDING to the preface of the book, the authors aim "to set forth the plant as a whole, with emphasis, so far as possible, upon those aspects of plant life which enter into the environment of the student." This they accomplish with a good measure of success.

Less extensive in its treatment than many of the other recent works, this text is obviously intended especially for a one-semester course. In general range of subject-matter it approximates the larger texts. The method of presentation, however, is radically different. Much of the technical detail has been omitted, and the more general features are emphasized.

Modern botanical research and interpretations are not overlooked. This is reflected in various ways: in the discussion of movement of materials in the plant; in the importance assigned to fossils in plant evolution; in the relationship portrayed between the algae and ferns on the one hand and the algae and the bryophytes on the other.

A glance at certain of the topics treated bears strong testimony that the authors have assembled botanical information of human interest and economic significance. To mention a few: the harvesting of the cork of commerce; the nature of the commercially important fibers of flax, hemp and sisal; the formation of coal; the manufacture of malted milk in connection with the digestion of starch; and the method of introducing nitrogen-fixing bacteria into the soil. These and similar topics give this book a decidedly human touch, and will make it valuable for assigned reading, even in courses in which more detailed subject-matter is included.

The style is direct and pleasant, with a journalistic flavor. The introduction of technical terms is kept at a minimum—an advantage to the student who does not need to acquire a scientific vocabulary. Summaries and literature references at the ends of the chapters are useful features, especially in a book that covers a wide field with no great emphasis on detail. This volume represents a new departure in the style of text-book writing; it should appeal strongly to the college undergraduate.

Plant Life. By D. B. SWINGLE. xiv + 441 pp. 290 figs. D. Van Nostrand Company, New York. 1935. $3.00.

DEPARTING less from the traditional treatments of the subject, this text again is intended for a short course, and consequently is limited in the quantity of

material considered. The scope is rather wide, however, and frequently the more interesting and striking features are emphasized. Thus attention is directed to the noteworthy cases of insect pollination in the fig and the *Yucca*. Similarly, the spectacular culturing of fungi by the leaf-cutting ants of the tropics and the courting home of the bower bird are described.

The aim of the author is to emphasize the functional rather than the morphological approach. In general the details of structure presented are no more than are sufficient for an understanding of the activities of the plants considered. The point of view is conservative, in certain respects perhaps too much so. Care is used in the introduction of technical terms, so that their meaning may be easily comprehended; and a glossary is appended. Selected review questions on the material covered in each of the chapters further enhance the pedagogical value of the book.

In part six, on "The Different Kinds of Plants," the Thallophyta are emphasized comparatively strongly, 103 pages being devoted to this division, and only 53 pages to the remainder of the plant kingdom. But this allotment of pages seems justified, since the other parts of the book deal especially with higher plants.

The style throughout is simple and easy to follow, though occasionally it smacks of the paternal. Elementary students should have no difficulty in using this text; those who do will profit especially by its simplicity and its logical presentation.

A Textbook of General Botany. By RICHARD M. HOLMAN and WILFRED W. ROBBINS. xiii + 626 pp. 463 figs. 3d edition. John Wiley and Sons, New York. 1934. $4.00.

THE third edition of this popular text-book obviously merits the approval with which the two previous editions were received. A little more than half of the book—Part I—is devoted to "The Structure and Physiology of Seed-bearing Plants." The first chapters deal with topics of wide import. Then follow chapters on the cell and on the nature and functions of the plant organs. Each of these is executed with exceeding care and thoroughness. A chapter of 63 pages, for instance, deals with the structure and physiology of the stem; one could hardly find a clearer and more concise treatment of the gross features, development, histological characters and physiology of the stem. The discussions of the other organs are equally good. Chapter 8, for example, deals with the fruit, seed and seedling in masterly fashion. The concluding chapter of Part I, on the "Relation of the Plant to its Environment," contains an excellent treatment of the conditions to which the plant is exposed, in addition to presenting the rather difficult subjects of plant invasion and plant succession.

Part II is a survey of the plant kingdom. The important groups are presented in clear, almost diagrammatic fashion. The authors include a fairly limited number of forms—for a large book—and present them in considerable detail. This makes for ease of understanding. In the chapter on the Spermatophyta the tendencies in the evolution of the flower are traced, and some of the possible relationships are indicated by means of charts. The concluding chapter deals with evolution, heredity and fossil plants. Modern literature has received consideration in the preparation of this treatise, and reference books are listed in the appendix.

Throughout, the style is simple and direct; there are frequent enumerations of significant points, and summaries are rather extensively introduced. Also, bold-face type and paragraph headings facilitate the use of the book. These features no doubt are in part responsible for the wide-spread popularity of this text. Unusual care has been taken in the preparation of the original illustrations, so that they are diagrammatically clear and well labeled; those that are borrowed have been judiciously selected. These many virtues make this text an outstanding one; it covers the field of modern botany in clear, concise fashion.

The subject is treated similarly, but much more briefly, in "Elements of Botany" by the same authors.

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SAM F. TRELEASE

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SPECIAL ARTICLES

CHEMICAL RELATIONSHIPS BETWEEN COMPOUNDS OF PHYSIOLOGICAL IMPORTANCE HAVING THE PHENANTHRENE NUCLEUS

THE following chart summarizes the chemical relationship between numerous classes of physiological compounds as given by investigators in many laboratories at present. About 1769 the main constituent of gallstones was isolated and soon recognized in bile itself. Chevreul gave it the name cholesterine from the Greek *chole,* meaning bile, and *steros,* solid. The name was later changed to "cholesterol" because it was shown to possess an alcoholic hydroxyl group. Sterols have been found in the cells of every class of living being so far investigated. They are especially abundant in nervous tissue of animals. That animals really can synthesize sterols has been demonstrated by ex-

periments with sterol-deficient diets. On diets containing sterols only limited amounts and kinds are absorbed by the gut. In general plant sterols (phytosterols) are not absorbed but the animal sterol, cholesterol, is absorbed. Vitamin D, which has been identified as a sterol, is likewise absorbed by the animal. Ergosterol, a plant sterol, has been shown to be absorbed to a small extent. In the gut there are anerobic organisms which produce coprosterol, the reduction product of the stereoisomer of cholesterol, allocholesterol. This compound has not been found in the animal tissues, although it can be produced in the laboratory by the action of HCl on cholesterol. The normal reduction product of cholesterol is β cholestanol. This is found in the tissues to the extent of from 2 to 3 per cent. of the total sterol.

Strecker in 1848 discovered that associated in the bile with cholesterol were the bile acids, especially glycocholic acid and taurocholic acid. He showed that these could be split by acids and alkalies into cholic acid, and glycine and taurine, respectively. In 1919 Windaus oxidized the hydrocarbon prepared by the reduction of coprosterol to the cholaic acid, the same compound Wieland had produced from the bile acids.

By 1933 Rosenheim and King, Windaus, Wieland, Butenandt and others had agreed that the phenanthrene-cycolpentane structure, now known as the cholane nucleus, met the specifications as the nucleus of the sterols and bile acids from both the physical and chemical points of view.

Upon irradiation of the plant sterol ergosterol, a nearly colorless resinous mass is obtained, from which a crystalline substance, calciferol, has been isolated. This compound has high antirachitic potency. Calciferol was considered to be vitamin D. Chemically, calciferol is isomeric with ergosterol, the change involving a shift in the position of the double bonds.

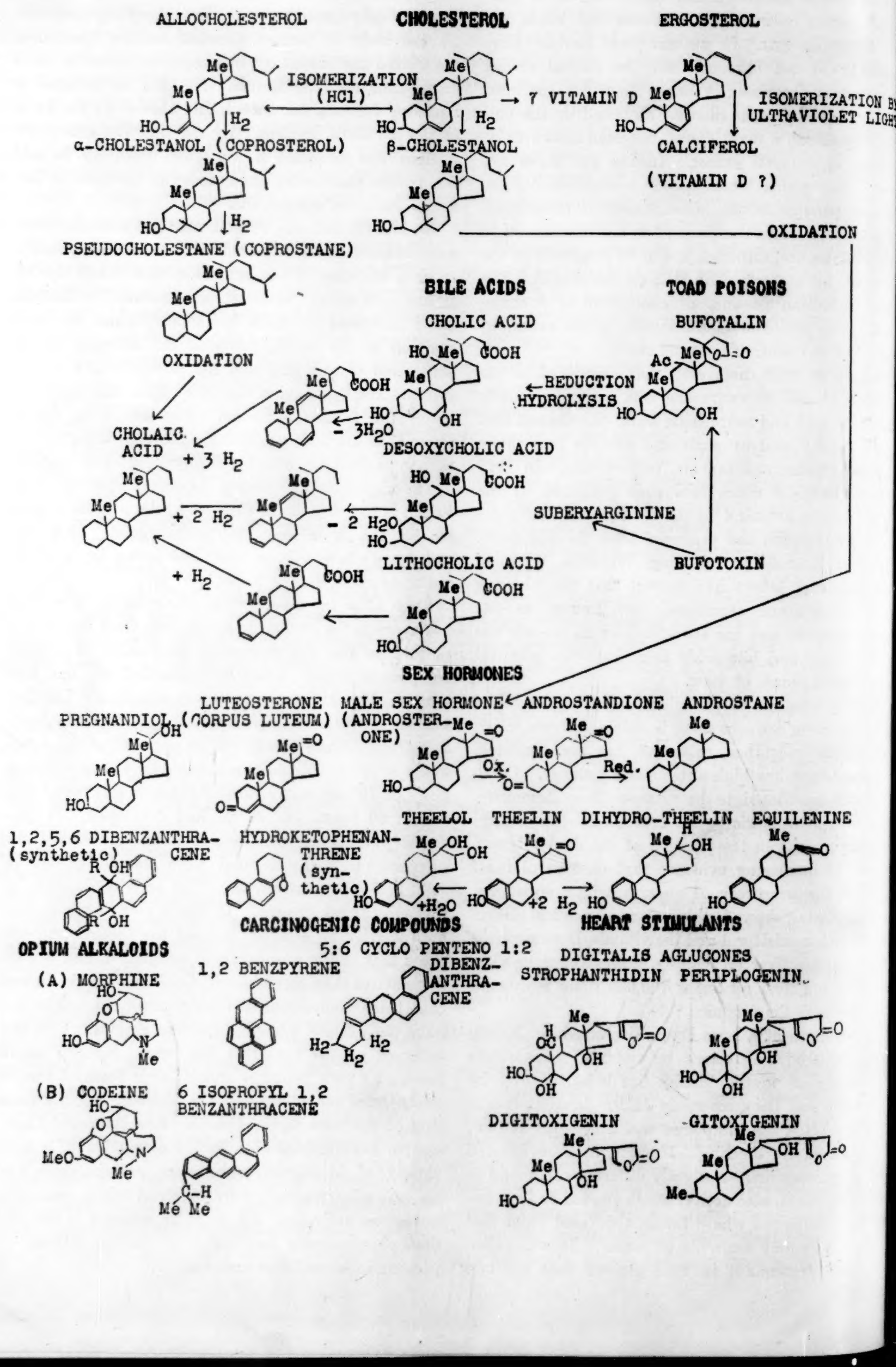
There is increasing evidence that cholesterol itself might be the precursor of an antirachitic substance. In 1933 Ender showed physical and chemical differences between calciferol and the vitamin D concentrate from tuna fish liver oil which contains the same vitamin D as cod liver oil but is 100,000 times more concentrated with the vitamin.

The isolation of a pure crystalline substance highly potent in producing estrus in castrated female rats was announced first by Doisy but independently by Butenandt and Dingemanse in 1929. In 1931 it was established that the compound was a hydroxy-ketone; Doisy named it "theelin." Marrian in 1930 isolated from pregnancy urine a slightly different compound in crystalline form, also active, which proved to be a trihydroxy compound whose formula differed from that of theelin by one molecule of water. It was called "theelol." Butenandt in 1931 showed that the two were present in the original urine and that theelol could be dehydrated to theelin by laboratory methods. On the basis of further chemical studies Butenandt recognized the similarity in properties between these compounds and the sterols. In 1931 he assigned a tentative formula for theelin and theelol on the basis of the old sterol nucleus. By the time the new sterol nucleus was accepted it was only necessary to add the groups and double bonds to write the present formulae for these compounds.

In 1934 Butenandt crystallized the male hormone and obtained a series of derivatives which suggested it to be in the class of compounds as theelin and theelol. It has been called "androsterone." Recently Ruzicka has synthesized the male hormone. It has the same skeleton as the female hormone but differing in the saturation of one ring and the presence of a methyl group. The hydroxyl is alcoholic rather than phenolic, as in the female hormone. Together with androsterone, in the male urine is the corresponding hydrocarbon androstane, but this is physiologically inert.

The corpus luteum secretes ~~luteosterone~~ progesterone, whose function it is to bring about changes in the uterine mucosa so that the ovum may become imbedded. This hormone has likewise been identified as having a phenanthrene cyclopentane nucleus.

Soon after the discovery of the relation of the sex hormones to the phenanthrene nucleus Cook and Dodds decided to test the estrogenic properties of organic compounds whose structure resembled the sex hormones. Phenanthrene itself was completely inactive, but the partly reduced compound 5, 6, 7-hexahydro-8-ketophenanthrene was found to possess definite estrogenic activity. When this compound was injected in doses of 100 mg into castrated rates, it was found that within 40 hours full estrus had developed. It produced puberty in immature females. Another series of compounds investigated were the derivatives of 1, 2, 5, 6-dibenzanthracene. The activity depends on the substituted groups. If the R's are both propyl and activity is 40 times that of the diethyl and 400 times that of the unsubstituted compound, and is even more active than theelol itself, Cook and Dodds showed that these compounds not only produced estrus but gave the positive plumage tests on capons. This test is based on the fact that the brown leghorn capon retains its male plumage and if large doses of theelin are injected subcutaneously the plumage changes from that of the male to the female. Aschheim and Hohlweg in 1933 showed that by the extraction of a wide variety of bituminous substances, certain coals and mineral oils, products were obtained which possessed estrogenic activities. Of great importance is the fact that phenanthrene and many of its derivatives are present in bituminous material.



ALLOCHOLESTEROL
CHOLESTEROL
ERGOSTEROL
ISOMERIZATION (HCl)
→ ? VITAMIN D
ISOMERIZATION BY ULTRAVIOLET LIGHT
α-CHOLESTANOL (COPROSTEROL)
β-CHOLESTANOL
CALCIFEROL (VITAMIN D ?)
OXIDATION
PSEUDOCHOLESTANE (COPROSTANE)
BILE ACIDS
TOAD POISONS
CHOLIC ACID
BUFOTALIN
OXIDATION
← REDUCTION HYDROLYSIS
CHOLAIC ACID
+ 3 H2
- 3H2O
DESOXYCHOLIC ACID
+ 2 H2
- 2 H2O
SUBERYARGININE
LITHOCHOLIC ACID
BUFOTOXIN
+ H2
SEX HORMONES
PREGNANDIOL
LUTEOSTERONE (CORPUS LUTEUM)
MALE SEX HORMONE (ANDROSTERONE)
ANDROSTANDIONE
ANDROSTANE
Ox.
Red.
THEELOL
THEELIN
DIHYDRO-THEELIN
EQUILENINE
+H2O
+2 H2
1,2,5,6 DIBENZANTHRACENE (synthetic)
HYDROKETOPHENANTHRENE (synthetic)
CARCINOGENIC COMPOUNDS
HEART STIMULANTS
OPIUM ALKALOIDS
5:6 CYCLO PENTENO 1:2 DIBENZANTHRACENE
DIGITALIS AGLUCONES
(A) MORPHINE
1,2 BENZPYRENE
STROPHANTHIDIN
PERIPLOGENIN
(B) CODEINE
6 ISOPROPYL 1,2 BENZANTHRACENE
DIGITOXIGENIN
GITOXIGENIN

It has been known for a long time that tar workers and chimney sweeps are very often victims of cancer. Many cases of industrial cancer can be traced to tar. In 1915 two Japanese workers demonstrated that on application of tar to the skin of rabbits for from 9 to 12 months symptoms of cancer were produced. Through the work of Kennaway in 1924 and 1925 and Mayneord in 1927 the carcinogenic compounds in tar were identified as belonging to the condensed ring systems, the similar type which was later shown to have estrogenic activity. Cook and Dodds actually found that many of the compounds which had estrogenic activity also had carcinogenic activity. As pointed out by Dodds the same criterion of structure for estrogenic activities seems to hold for carcinogenic activity. There are, however, compounds having carcinogenic activity which do not have estrogenic activity and *vice versa.* A very interesting example is calciferol, which possesses estrogenic activity but not carcinogenic activity. A very potent carcinogenic compound isolated from coal tar is 1, 2-benzpyrene. In a paper last year Rofo showed that rats subjected to ultra-violet irradiation over a period of from 7 to 8 months developed tumors (carcinomas and sarcomas). Accompanying the malignancy there was a local increase in cholesterol in the same regions.

The phenanthrene nucleus is found in the opium alkaloids, morphine and codeine and their derivatives. Work on these compounds is going on in the laboratory of Eddy. The recent investigations of Jacobs and Elderfield have shown the cholane nucleus in the digitalis aglucones.

Among the principles isolated from toad poisons are compounds which have been shown in the laboratories of Wieland and of Chen and Chen to belong to the cholane ring system. Bufotoxin gives on hydrolysis suberyl arginine and bufotalin. The latter on hydrolysis and reduction gives cholic acid.

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THE PRESENCE IN SELF-BLANCHING CELERY OF UNSATURATED COMPOUNDS WITH PHYSIOLOGICAL ACTION SIMILAR TO ETHYLENE[1]

THE characteristic petiolar curvature of the leaves of tomato plants that is produced in the presence of low concentrations of certain substances having carbon-to-carbon double linkages may be used as a highly sensitive qualitative test for the presence of these compounds. Crocker[2] states that the test is sensitive to one part in ten million of ethylene. This test was used in an attempt to ascertain whether or not an unsaturated compound is present in the blanched areas of celery.

The celery used was of the Golden Self-Blanching variety grown in the greenhouse in eight-inch pots. Harvey[3] has pointed out that the appearance of the leaves of this variety is frequently such as to indicate the presence of mosaic virus in the self-blanching leaves. Stalks and leaves were used when in such condition that the stalks were white and the leaves yellow, mottled with green. The tests were conducted in a building in which there were no illuminating gas connections in order to exclude an external source of unsaturated hydrocarbon. In some cases potted tomato plants were used; in others, the severed top of a tomato plant was placed in water and used. Suitable curvatures were obtained by either procedure.

Fifteen to twenty grams of stalks and leaves of Golden Self-Blanching celery were cut into pieces about an inch long without bruising and placed in a desiccator. The desiccator was evacuated at once to a pressure of about thirty millimeters of mercury with a vacuum pump and placed for two hours in an icebox kept at 12° to 14° C. At the end of this time it was connected by means of a one-inch section of rubber tubing to a bell jar containing a tomato plant. The pressure in the bell jar was reduced to half an atmosphere, and the gases contained in the desiccator were forced into the bell jar by filling the desiccator with tap water. Atmospheric pressure was restored in the bell jar, all connections were sealed, and it was allowed to stand for two and one half hours in a warm (25° to 30° C.) place out of direct sunlight. At the end of this time observation was made to determine whether any curvature of the leaves was produced.

In eight out of ten tests made upon celery which was strongly blanched, a marked curvature of the topmost leaf of the tomato plant was produced, with the lower leaves showing progressively less curvature.

The same procedure was carried through with the same apparatus but without the blanching celery. In no case was the characteristic curvature observed. In another series of experiments grass-green Winter Queen celery was used in place of the naturally blanching celery, with the result that no curvature was produced. This indicates that only celery which is in the blanching condition produced detectable amounts of the substance responsible for the curvature.

Since little was known as to the specificity of this test for unsaturation, a number of compounds were tested to determine whether or not they would produce the reaction. Propylene, butylene and

[1] Published by permission of the director of the Agricultural Experiment Station as Journal Series Paper No. 1337.

[2] Wm. Crocker, SCIENCE, 75: 1948, Suppl., p. 11. 1932.

[3] R. B. Harvey, Minn. Agr. Expt. Sta. Bul. 222, 1925.

amylene, homologues of ethylene; mesityl oxide, $(CH_3)_2C:CHCOCH_3$, an unsaturated ketone; and vinyl acetate, $CH_3COOCH:CH_2$, an ester of an unsaturated alcohol, all gave positive reactions.

Dichloroethylene, CHCl: CHCl; trichloroethylene and tetrachloroethylene failed to give the reaction. This is undoubtedly accounted for by the fact that a substituent on a double bond carbon affects the reactivity of the double bond, which seems to be necessary to produce the reaction.

Acetone, acetaldehyde, diethyl ether and chloroform failed to give the reaction.

From these facts it seems likely that some gaseous or volatile unsaturated hydrocarbon or similar compound is present in Golden Self-Blanching celery during natural blanching of the leaves. The celery, Winter Queen, which is not self-blanching, does not produce such substances. It seems indicated therefrom that the disappearance of chlorophyll from self-blanching celery is accomplished by some process similar to that by which celery is commonly blanched artificially by application of ethylene in low concentrations.[4]

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NEW CANCER-PRODUCING HYDROCARBONS

Two hydrocarbons, belonging to series not hitherto known to be active as agents for cancer production, have been found to cause malignant growths in mice. These two compounds are sym.-triphenylbenzene and tetraphenylmethane. Their action is slower than that of the substances discovered by Cook[1] and coworkers. A specific strain of mice was treated to weekly injections amounting to 1 cc of a 5 per cent. solution of triphenylbenzene in sesame oil. In a year's time 12 out of 60 mice had well-developed tumors of a highly malignant type. In the case of tetraphenylmethane 25 mice were painted twice weekly with a 0.5 per cent. solution in benzene. After the same period well-developed epitheliomata were present in 8 cases. It is interesting to note that the percentage of positive results is relatively high in spite of the long time necessary to induce the growth.

The interest which these results arouse is chiefly in the complete lack of resemblance of these new compounds to the hydrocarbons discovered by Cook. The compounds[2] investigated by him had condensed ring systems containing 4 to 5 aromatic rings in the molecule and possessed a phenanthrene nucleus. He found that the ring system of 1, 2-benzanthracene[3] is present in many cases, although not absolutely necessary. He also observed a possible relationship[4] with the dehydrogenation products of the sex hormones and bile acids. Triphenylbenzene and tetraphenylmethane possess nothing in common with the properties listed above, except that each contains 4 benzene rings. The significance, if any, of this point is not evident at present. Any other structural similarity is lacking, for there is a complete absence of condensed ring systems or a phenanthrene nucleus in the two new agents. Neither may they be derived from the sex hormones or the bile acids.

In triphenylbenzene a single ring holds three other benzene rings attached in the 1, 3, 5 positions, but in tetraphenylmethane no benzene ring is attached to another. The linkages in this last instance are through a central carbon atom. In an effort to find a common ground on which these widely different classes of carcinogenically active agents can stand we may make the tentative assumption that in the hydrocarbons so far discovered the property of producing cancer resides in the benzene nucleus as modified or affected by substituents attached in either the condensed or open manner. Work is now in progress to limit more exactly the nature and position of the substituents. We are also investigating the higher phenyl homologues of the above-named series in the expectation that they may be more active still in causing tumorous growths.

The work is being conducted under a joint program of research of the Evans Memorial Hospital of Boston and the Massachusetts Institute of Technology at Cambridge.

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THE FORMATION OF CARBOHYDRATE FROM GLYCEROPHOSPHATE IN THE LIVER OF THE RAT

GEMMILL and Holmes[1] reported recently that the carbohydrate content of liver slices from butter-fed rats increases during 3 hours' incubation in bicar-

[4] Since the work described was completed for publication, it came to the authors' attention that R. Gane had published in *Nature*, December 29, 1934, Vol. 134, p. 1008, a paper entitled "The Presence of Ethylene in Some Ripening Fruits."

[1] Cook, Hieger, Kennaway and Mayneord, *Proc. Roy. Soc.*, B, 111: 455, 1932; Cook, 485.

[2] Cook, *Proc. Roy. Soc.*, B 113: 273, 1933.

[3] Cook, *Jour. Chem. Soc.*, 1592, 1933.

[4] Cook, *Proc. Roy. Soc.*, B 113: 273, 1933; Cook and Haslewood, *Jour. Chem. Soc.*, 428, 1934.

[1] C. L. Gemmill and E. G. Holmes, *Biochem. Jour.*, 29: 338, 1935.

bonate-Ringer's solution and that this carbohydrate synthesis is associated with respiratory quotients below 0.7. Since lactic acid was not present in sufficient quantity, they assumed that the newly formed carbohydrate originated from fat.

It was noted in this laboratory that the inorganic phosphate content increases and the phosphate fraction difficult to hydrolyze in N HCl decreases when liver slices of rats are shaken for 3 hours in oxygenated bicarbonate-Ringer's solution. This suggested that glycerophosphate might be a source of carbohydrate in the liver.

Of 3 equal portions of liver slices from fasted rats, one was analyzed after 15 minutes for its total (fermentable) carbohydrate content, while the other 2 portions were incubated for 3 hours, one without and one with added substrate and then analyzed in the same manner as the first portion. Addition of α- or β-glycerophosphate or of glycerol caused in each case a greater increase in fermentable carbohydrate content than incubation of the liver without added substrate. The phosphorylized products were more active than glycerol. Under anaerobic conditions an increase of the carbohydrate content of the liver did not take place.

It was ascertained that during incubation of liver slices with α-glycerophosphate more inorganic phosphate was liberated than during incubation without added substrate. In muscle α-glycerophosphate interacts with pyruvic acid to form dihydroxyacetonephosphate and lactic acid. The mechanism of carbohydrate synthesis in the liver may be different, because addition of pyruvic acid or alanine (which would be deaminized to pyruvic acid) either alone or with α-glycerophosphate has so far not given clear-cut results.

The present experiments emphasize the importance of the glycerol part of the lipid molecule as a source of carbohydrate in the body and they do not lend support to the idea that fatty acids are converted to carbohydrate in the mammalian liver.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

BACTERIOLOGICAL EXAMINATION OF THE CONTENTS OF THE CLOSED ARM IN THE SMITH FERMENTATION TUBE

How often has the curiosity of the bacteriologist been directed to the chemical or biological conditions induced by bacterial flora under anaerobic environment in the closed arm of the Smith fermentation tube, and how often has he been foiled in securing an uncontaminated sample! Attempts to solve this problem have been made in the past, first, by substituting the so-called fish-hook tube with open ends, the longer of which was stoppered; and next, by the introduction by Hill[1] of a modified Smith tube, where the upper end was left opened and into which a glass thimble was made to fit snugly by ground glass surfaces.

In the first case, practical difficulties were encountered, owing to the frequent unexpected loosening of the stopper in the upper end of the fish-hook tube; to inability to readily handle such tubes in racks or other types of holders; and also to the impossibility of utilizing large quantities of inoculum. In the case of Hill's modification of the Smith tube, it was found that by repeated sterilization procedures the upper end of the tube or the thimble would crack and so render the tube useless, and annoyances were encountered in fitting the proper thimble into the end of a tube, where a series of such tubes were being cleaned up after use.

To obviate all these difficulties, and in fact to make the object of the removal of the contents of the closed arm easily carried out, the writer suggests the procedure which follows:

The usual footless type of the Smith fermentation tube (A.P.H.A. model) is taken, and with the thumb held firmly over the opening of the bowl, the end of the tube is brought in contact with a small-sized jet of flaming gas of a blast burner, being careful that the point of the flame impinges centrally on the closed end of the tube. As the glass begins to melt the enclosed air within the tube expands and blows out a small opening in the end of the tube. Everted edges of the opening are now to be held in the flame for a period sufficiently long to produce retraction of the everted lip of the opening to a level with the remaining surface of the glass. It should be the object of the operator to form an opening somewhere close to 3 mm; such an opening will readily accommodate either the passage of a fair-sized hypodermic needle or the drawn-out end of a glass pipette.

The next step involves the use of a method to effectually seal the opening made in the closed arm of the tube, and at the same time to offer later on the minimum of resistance to the passage of the hypodermic

[1] *Jour. Boston Soc. Med. Sci.*, January, 1899.

needle or glass pipette. This is accomplished by carefully fitting on a "Viscose cap" of a diameter of 16 mm and a length of 19 mm, such as is made by the Dupont Cellophane Company of New York. The tube, or tubes, should then be set aside at room temperature to permit the caps to shrink down slowly and snugly on the tube and to become perfectly dry. Attempts to hasten this by drying in a hot-air oven is not recommended, as the viscose caps tend to wrinkle and lead to the production of air channels which would defeat the purpose of the whole process, as leakage of the contents outwards during sterilization and suction of air within the tube upon cooling would result, not to mention subsequent contamination of the sterile contents of the tube.

When the viscose cap is found to be thoroughly dry and closely adherent, without any imperfections such as described, the tubes may then be filled with dextrose or other broths and sterilized in the usual way in the autoclave at 15 pounds for fifteen minutes. It will be found after sterilization that the adhesive properties of the viscose caps have in no wise undergone any deterioration and the seal, in consequence, remains intact.

Following upon subsequent inoculation and incubation, removal of samples from the contents of the closed arm is carried out by piercing through the cellulose cap directly over the hole in the upper end of the closed arm of the tube by simple pressure of the point of the needle of the hypodermic syringe, or by a drilling motion with pressure applied to the broken-off end of the capillary shank of a glass pipette, to which one has previously affixed at the proper end a small rubber bulb for suction purposes. Of course, before using the hypodermic needle or glass pipette, one must observe to remove the cotton plug and substitute a cork or a rubber stopper; otherwise, upon breaking open the sealed end, air pressure would cause the contents of the closed arm to immediately flow into the bowl.

The writer has found upon repeated tests that this method of the examination of the contents of the closed arm of a Smith fermentation tube may be regarded as easy, adequate and trustworthy.

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A DEVICE FOR AERATING AND CIRCULATING AQUARIUM WATER

A COMPACT, efficient air-water pump for aerating and circulating the water in an aquarium or water bath is illustrated in Fig. 1. In use, no parts of the apparatus other than the air inlet tube remain outside of the water container.

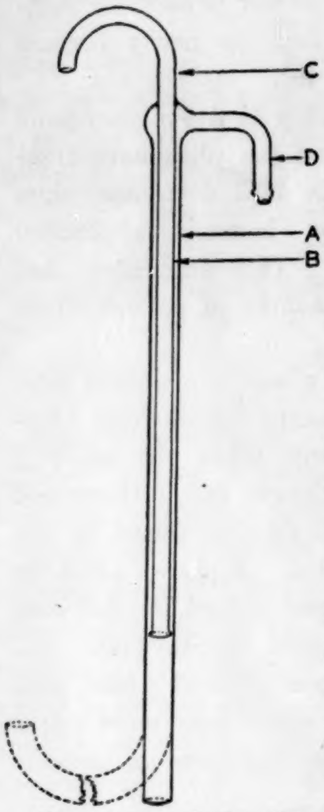

FIG. 1. A device for aerating and circulating aquarium water.

The apparatus consists of a Pyrex tube A of suitable length, with an inside diameter of 0.8–1.0 cm, inside of which is sealed a shorter glass tube B which connects to an outlet tube C of any desired shape or size. An air inlet tube D is sealed to the upper end of tube A.

The length of the submerged portion of tube A should be at least twice that of the unsubmerged portion of the apparatus. Air under low pressure is forced in at D and escapes into tube B. Due to hydrostatic pressure a column of water forms ahead of each bubble of escaping air and is forced through the outlet tube into the aquarium or other container.

The rate of air-water flow is controlled either by varying the air pressure or by changing the diameter of tube B. A maximum flow of about 150 cc of water per minute can be obtained by the use of glass tubing of 5 mm inside diameter, whereas a maximum flow of about 500 cc of water per minute can be obtained by the use of 8 mm tubing.

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